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ANNUAL REPORT
2017- 2018

ALL INDIA COORDINATED RESEARCH PROJECT (ICAR)

ON

POST HARVEST ENGINEERING AND TECHNOLOGY

JUNAGADH CENTRE

Presented at the

34rd Annual Workshop to be held at
Tamil Nadu Agricultural University
Coimbtore (Tamil Nadu)

March 12 -15, 2018

AICRP on Post Harvest Engineering and Technology
Department of Processing and Food Engineering
College of Agricultural Engineering & Technology
Junagadh Agricultural University
JUNAGADH – 362001

FOREWORD

Post-harvest engineering and technology deals with the application of engineering concepts to foods after harvesting, like processing of grains, fruits, vegetables, animal products, milk and other foods for preservation, value addition, making different products by using operations like cooling, peeling, grading, storage, pasteurization, sterilization, refrigeration, heat and mass transfer operations. It has to develop in consonance with the needs of each society to stimulate agricultural production; prevent post-harvest losses, improve nutrition and add value to the products. In this process, it must be able to generate employment, reduce poverty and stimulate growth of other related economic sectors. The process of developing of post-harvest technology and its purposeful use needs an inter-disciplinary and multi-dimensional approach, which must include, scientific creativity, technological innovations, commercial entrepreneurship and institutions capable of inter-disciplinary research and development all of which must respond in an integrated manner to the developmental needs..

The Junagadh centre contributed industriously by establishing agro processing centres, utilization of solar energy for drying of groundnut pod, reducing time of curing of onion to facilitate the land for new crops, development of machines for fruits cleaning and grading etc. In view of the shortage of capital, an arrangement of custom hiring service facility was provided to the farmers in meeting the requirements for onion storage. The centre has brought fruitful findings on the storage of oil seeds, cereals and spice crops. These findings of research work became useful to farmers, industries and entrepreneurs.

As per the need of this region, the Junagadh centre has functioned constantly and advanced technologies related to feed block making machine, solar dryer cum green house, peanut butter, coriander dhal milling process, vacuum packaging of mangoes, storage technique for coriander and wheat (seed), onion storage structures, sapota cleaner, pectin extraction, enzyme extraction etc. for the benefit of farmers and processing industries. However, in view of the recent trends, still much remains to be done. This centre has space for laboratory work, office room, analytical facilities, etc., but due do continuous expansion and with a view to impart training and accommodate precious and sensitive instruments / equipments purchased so far, this centre need a separate building / space for better sitting and laboratory arrangements, for which necessary efforts are being made to fulfill the same at university level.

The financial assistance provided by the ICAR under the AICRP on Post Harvest Engineering and Technology is gratefully acknowledged. I am sure the Junagadh centre will give considerably towards need of the agro industries and the life flourishing of the farmers of the region.

15 February, 2019
Junagadh

(N. K. Gontia)
Principal & Dean
College of Agril.Engg.& Technology
JAU, Junagadh

ACKNOWLEDGEMENT

The All India Coordinated Research Project on Post Harvest Engineering and Technology staff wish to communicate their earnest thanks to Dr. A. H. Pathak, Vice-Chancellor, Junagadh Agricultural University, Junagadh and Dr. N. K. Gontia, Principal & Dean, College of Agricultural Engineering & Technology, Junagadh for their valuable guidance, thought stimulating observations and deep attentiveness shown in the happenings of the scheme. We hereby definite our solemn thanks to Dr. V. P. Chovatia, Director of Research, for able monitoring of the scheme work and Sh. S. K. Jethani, Comptroller Junagadh Agricultural University, Junagadh for undertaking financial matters promptly.

The staff members of the scheme graciously distinguish the financial assistance received by ICAR to run the scheme assuredly. The positive tactic and appreciated remark of Dr. K. Alagusundaram, Deputy Director General (Engineering) and Dr. S. N. Jha, Assistant Director General (PE) ICAR, New Delhi are gratefully recognized. We express our most straightforward acknowledgements to Dr. S. K. Tyagi, Project Coordinator, AICRP on Post Harvest Engineering and Technology, Central Institute of Post-Harvest Engineering & Technology, Ludhiana for their inspiring leadership, coordination as well as their keen interest in the activities of the scheme.

We are also greatful to all the staff members of the Department of Processing and Food Engineering especially Prof. D. M. Vyas, Professor and Head, for their support and taking due interest in the activities of the scheme work. The staff members of the scheme also appreciate and thankfully accepts the cooperation rendered by agro processing centers for promoting nearby farmers and taking interest, post-harvest industries for providing details during visits in connection with input for research work and more who helped directly or indirectly for this scheme.

March 05, 2019
Junagadh

(M. N. Dabhi)
Research Engineer
for Scheme Staff

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ALL INDIA CO-ORDINATED RESEARCH PROJECT (ICAR)

ON

POST HARVEST ENGINEERING AND TECHNOLOGY SCHEME

JUNAGADH AGRICULTURAL UNIVERSITY

JUNAGADH CENTRE

GENERAL INFORMATION

1.	**Title of the scheme**	:	All India Co-ordinated Research Project (ICAR) on Post Harvest Engineering and Technology
2.	**ICAR sanction No. & Date**	**:**	1(41)/PHT/2006/XI Plan/1010998, dtd. 21.3.2009 (PC letter No.)
3.	**Date of commencement**	**:**	April, 1980
4.	**Date of completion**	:	The scheme is sanctioned for the 12th Five Year Plan
5.	**Sanctioned grant for the Year 2017-2018 for which this report is presented**	:	Rs**.** 93.20 lakh (ICAR+State)

6. Staff position in the scheme

Sr. No.	Designation	No. of posts			Name of the incumbent	Present Scale of pay	Date of joining / Vacant
		S	F	V			
1.	Research Engineer (37400-67000)	1	1	-	Dr. M. N. Dabhi	37400-67000	01.09.2016
2.	Asstt. Bio-Chemist (15600-39100)	1	1	-	Dr. P. J. Rathod	15600-39100	01.12.2018
*3.	Asstt. Entomologist (15600-39100)	1	1	-	Prof. R.D.Dhudashia	37400-67000	01.06.1997
4.	Asstt. Food Microbiologist (15600-39100)	1	1	-	Prof. A.M. Joshi	15600-39100	18.02.2009
5.	Asstt. Res. Engineer (ASPE) (15600-39100)	1	1	-	Prof. P. R.Davara	15600-39100	01.01.2011
6.	Asstt. Process Engr. (Testing & Eva.) (15600-39100)	1	-	1	Dr. S. P. Cholera	15600-39100	01.04.2015
7.	Senior Tech. Asstt. (5500-9000)	1	1	-	Er. H. R. Sojaliya	17000 (fixed)	14.02.2012
8.	Investigator (5500-9000)	1	1	-	Er. P. P. Vora	10000 (fixed)	16.03.2012
9.	Draftman (Mech.) (5000-8000)	1	1	-	Shri D.M. Pethani	9300-34800	04.08.1987
10.	Craftman-I (Welder)	1	1	-	Shri V. S. Kava	5200-20200	01.11.2014
11.	Craftman-II (Fitter)	1	1	-	Shri N.V. Vora	5200-20200	28.12.2008
12.	Craftman-III (Tinsmith)	1	-	1	Vacant	5200-20200	1.07.2016
13.	Senior Mechanic	1	1	-	Shri A. P. Zezariya	5200-20200	26.07.2018

Note :

* Post mentioned above is getting higher pay scales as per university rules.

7. Expenditure Statement for the year 2016-2017 (Upto March, 2017)

Head-wise breakup of Receipts, Expenditure and Closing Balances for the financial year 2017-18 (ICAR share)

Period : 01-04-2017 to 31-03-2018

Sr. No.	Budget Head	Opening balance as on 01-04-2017 Rs.	Grant received during the year 2017-18 Rs.	Amount of Receipt during the year Rs.	Total grant Rs. (3+4+5)	Expenditure incurred for the councils share during the year 2017-18 Rs.	Refund of unspent balance of the year 2016-17 (Balance of previous five year plan : 2012-13 to 2016-17) Rs.	Closing balance at the end of the year 2017-18 as on 31-03-2018 Rs. (6-7-8)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	Pay and Allowances	2,16,570.00	85,00,000.00	-	87,16,570.00	76,56,250.00	2,16,570.00	8,43,750.00
2	Travelling Allowance	1,82,784.00	2,00,000.00	-	3,82,784.00	55,290.00	1,82,784.00	1,44,710.00
3	Recurring Contingencies (Including HRD)	1,757.00	5,50,000.00	-	5,51,757.00	3,03,428.00	1,757.00	2,46,572.00
4	Non recurring contingencies	62,508.00	70,000.00	-	1,32,508.00	-	62,508.00	70,000.00
5	**Total, Rs.**	**4,63,619.00**	**93,20,000.00**	-	**97,83,619.00**	**80,14,968.00**	**4,63,619.00**	**13,05,032.00**
6	Receipt during the year 2017-18	-	-	10,646.00	10,646.00	-	-	10,646.00
7	**Total grant, Rs.**	**4,63,619.00**	**93,20,000.00**	**10,646.00**	**97,94,265.00**	**80,14,968.00**	**4,63,619.00**	**13,15,678.00**

8. Technical Programme

Sr.No.	Code No.	Title
1	PH/JU/85/1	Establishment of Agro Processing Centre training and demonstration of technologies (Operational research project on Agro Processing Centres)
2	PH/JU/2016/01/01	Design and development of on farm solar assisted dryer for drying of ground nut pods for longer storage.
3	PH/JU/2016/01/02	To study the effect of different packing materials against Groundnut Bruchid (Caryedon serratus Olivier) during storage.
4	PH/JU/2017/01	Forced air curing of onion
5	PH/JU/2017/02	Testing of ozonization against storage insect pest of wheat.
6	PH/JU/2018/01	Development of high protein extruded product using defatted peanut flour.
7	PH/JU/2018/02	Design and development of grain treater for enzymatic pre-treatment to pigeon pea grains

Investigation No. : 1

1.1 Scheme code No. : **PH/JU/85/1**

1.2 Title of Investigation: Establishment of Agro Processing Centre training and demonstration of technologies (Operational research project on Agro Processing Centres)

1.3 Name of Investigators:
1. Dr. M. N. Dabhi
2. Prof. P. R. Davara
3. Prof. D. M. Vyas
4. Er. P. P. Vora

1.4 Objectives

1. Survey of selected villages to identify the available agro-processing equipment.
2. To transfer the developed and improved agro-processing equipment to the selected village to give value added product.
3. To evaluate the techno-economic feasibility of the agro-processing centre.

1.5 Justification

Migration from the village to the cities not only disturbs the rural based economy but also causes a saturated and explosive urban population growth. The dire need of the hour is to prevent this migratory trend from villages to cities, so as to increase the activities concerned with farming thereby increase food production. This could be prevented by stabilizing industries in the proximity of the source of raw materials or near the vicinity of consumption catchment's area to avoid higher transportation cost. This will help the village to become self sufficient in production, processing and consumption of raw materials produce by them. More job opportunities would also be created, resulting in more income generation.

1.6 Date of start: April - 2012

1.7 Date of completion: Continue

1.8 Past Work done

Major equipment installed at agro processing centres were used for their operational work. In this period, oil milling, spice milling, groundnut decorticating, groundnut threshing, cleaning and grading of wheat were taken up. The detailed operational performance data and expenditure incurred, income obtained along with profit / loss were determined.

1.9 Progress of work

Agro processing centers were visited for monitoring the progress made by the centers. Loej, Virol and Tadka pipaliya centre has also deposited installment for the year 2017-18. The detailed operational performance data and expenditure incurred, income obtained along with profit / loss were determined and presented in Table: 1.1.

Table 1.1 : Operational performance and income from the processed products

S. N.	Activities	Raw material processed (kg)	Finished material produced (kg)	Expenditure incurred (Rs.)	Income (Rs.)	Net income (Rs.)
	Tadaka Pipaliya Agro Processing Centre					
1	Oil milling (groundnut)	7830 kg	-	15660 (@ 2 Rs./kg.)	31320 (@ 4Rs./kg.)	15660
2	Cleaning and grading of wheat,	2580 kg	-	-	2580 (@ 1 Rs/kg.)	2580
3	Groundnut decortication (manually)	-	_	_	750 (@ 20Rs/day x 2 nos.)	750
4	Sesame processing	178 kg	-	3560	8900	5340
5	Groundnut threshing				4750 (@250Rs./hr; Total 19 hrs.)	4750
6	Pulse mill	526 kg		1052	5260	4208
	Loej Agro Processing Centre					
1	Oil milling (groundnut)	85000 kg	-	170000 (@ 2 Rs./kg.)	340000 (@ 4Rs./kg.)	170000
2	Cleaning and grading of wheat,	4870 kg	-	-	4870 (@ 1Rs./kg.)	4870
	Virol Agro Processing Centre					
1	Oil milling (groundnut)	73000 kg	-	146000 (@ 2 Rs./kg.)	292000 (@ 4 Rs./kg.)	146000
2	Cleaning and grading of wheat,	5830 kg	-	-	5830 (@ 1 Rs./kg.)	5830
3	Spice milling	575 kg Chilly 72 kg turmeric	-	1458	7290	5832

		82 kg cumin Total 729				
	Panchal Vikas Mandal, Chotila					
1.	Oil milling	2000 kg	-	4000 (@ 2 Rs./kg.)	8000 (@ 4Rs./kg.)	4000

1.10 Conclusion:

Agro Processing Centres are running very well for utilization of processing machinery and processing of farmers produce at village level.

1.11 Future plan of work

The experiment will be continued.

Oil milling

Pulse milling

Threshing of groundnut

Tal ni sani

Spice processing

Plate 1.1 Activities at Agro Processing Centres

Project – 2

Title : Value Chain on groundnut

This project is divided in two different investigation.

Investigation – 1 : Design and development of on-farm solar assisted dryer for drying of groundnut pods for longer storage.

Investigation – 2 : To study the effect of different packing materials against Groundnut Bruchid (Caryedon serratus Olivier.) during storage

Project – 1

Value Chain on groundnut

Investigation No. : 1

(Scheme code No. : PH/JU/2016/01/01)

ANNEXURE - V
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)
(Refer for Guidelines ANNEXURE-XI (E))

1. **Institute Project Code** : PH/JU/2016/01/01
2. **Project Title** : Design and development of on farm solar assisted dryer for drying of ground nut pods for longer storage.
3. **Reporting Period** : 2018– 19 (January, 2018 to December, 2018)
4. **Project Duration**: Date of Start - June, 2016 Likely Date of Completion – June, 2019
5. **Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions/deletions**

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. S. P. Cholera	PI	50 %	Design, fabrication, testing and performance evaluation of developed dryer
2.	Prof. R. D. Dhudeshiya	Co-PI	10 %	Entomological analysis
3.	Prof. A. M. Joshi	Co-PI	10 %	Microbiological analysis
4.	Dr. P. N. Sarsavadia	Co-PI	10 %	Designing of dryer
5.	Dr. M. N. Dabhi	Co-PI	10 %	Monitoring and helping in Design, fabrication, testing and performance evaluation of developed dryer
6.	Dr. P. J. Rathod	Co-PI	10 %	Food safety

6. (a) Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1 Design and development of on farm solar assisted dryer for drying of groundnut Pods	Fabrication of dryer was completed as per the design and comprises of following components. (1) Drying chamber (12 nos trays) with a capacity of 125 kg (2) Solar collectors (8 nos.) of size 1 x 2 m. (3) Heating unit (8 kW) with 6 coils (4) Blower (1.5 hp) (air unit) All components were connected with insulated connecting ducts	Dr. S. P. Cholera, Dr. P.N. Sarsarvadia Dr. M. N. Dabhi	50 % 10 % 10 %	100 %
2. To study drying characteristics of groundnut pods using developed dryer	The drying characteristics of threshed groundnut pods of GG 20 were evaluated at different drying air temperature (45 ^{0}C and 50 ^{0}C) and air velocity (0.50 m/s and 1.0 m/s) using the developed dryer.	Dr. S. P. Cholera, Dr. M. N. Dabhi	50 % 10 %	100 %
3. To evaluate the quality of the dried groundnut pods during storage period.	The quality evaluation of groundnut kernels dried by traditional sun drying and developed dryer during the storage is under progress and will be completed on July-2018.	Prof. A. M. Joshi Prof. R.D.Dhudeshiya Dr. P. J. Rathod	50 % 10 % 10 % 10 %	70 %
4.To evaluate the performance of the developed dryer.	The performance evaluation of the developed dryer was carried out under no load and full load (4 different combination of temperature and air velocity)	Dr. S. P. Cholera, Dr. M. N. Dabhi	50 % 10 %	100 %
5 To study the economic feasibility of the developed dryer	Cost economic of drying by using developed dryer was studied.	Dr. S. P. Cholera, Dr. M. N. Dabhi	50 % 10 %	100 %

(b) If shortfall/addition, reasons for the same and how to catch up with the intended activities: NA

7. Annual Progress Report (research results and achievements in bullets)

The experiment on drying characteristics of groundnut pods was repeated for the second year (i.e., 2018-19) in the month of December – 2018 as per following details.

(a) Drying characteristics of groundnut pods using on farm solar assisted dryer

- Groundnut pods (GG -20) immediately after threshing were procured from village Kathrota (Taluka : Visavadar) of Junagadh district. The groundnut pods (GG – 20) were used to evaluate the drying characteristics of the developed dryer.
- Groundnut pods were cleaned and graded by groundnut pod grader available in the Department of Processing and Food Engineering. After removal of small sized / damaged groundnut pods and other impurities from the lots, groundnut pods were weighed.
- The experiment on drying of groundnut pods was carried out in the month of December - 2018.
- Each tray of dryer loaded with 10 kg of well graded and cleaned groundnut pods. Total 120 kg of groundnut pods loaded in 12 trays. Initial moisture content of threshed groundnut pods was measured before drying by hot air oven method. The mean of moisture content of threshed groundnut pod was found 13.90 % (wb).
- Drying characteristics of groundnut pods under different treatment combinations was determined as per the following details.
  (i) T_1 – 45 ^{0}C drying air temperature and 0.50 m/s air velocity
  (ii) T_2 – 45 ^{0}C drying air temperature and 1.0 m/s air velocity
  (iii) T_3 – 50 ^{0}C drying air temperature and 0.50 m/s air velocity
  (iv) T_4 – 50 ^{0}C drying air temperature and 1.0 m/s air velocity
- The values of moisture content, drying rate and moisture ratio of groundnut pods for different treatments T_1, T_2, T_3 and T_4 for different trays are reported in Table 7.1, Table 7.2, Table 7.3 and Table 7.4, respectively.
- Graphical representation of values of drying time vs moisture content, drying time vs drying rate and drying time vs moisture ratio are illustrated in Fig. 7.1 to 7.4, Fig.7.5 to 7.8 and Fig. 7.9 to 7.12, respectively.
- It was observed that highest drying rates were found in different drying trays (i.e., 13.00 to 14.00 am) for all the four treatments (i.e., T_1 to T_4).
- Also, the values of drying constant for treatment T_1, T_2, T_3 and T_4 are found to be 0.14 h^{-1}, 0.15 h^{-1}, 0.16 h^{-1} and 0.17 h^{-1}, respectively.
- This indicated that as the air velocity increases from 0.50 m/s to 1.0 m/s at constant temperature of 45^0 C, the value of drying constant also increased from 0.14 h^{-1} to 0.15 h^{-1}, respectively (i.e., treatment T_1 and T_2).
- Similarly it was also observed that as the air velocity increased from 0.50 m/s to 1.0 m/s at constant temperature of 50^0 C, value of drying constant also increased from 0.16 h^{-1} to 0.17^{-1}, respectively (i.e., treatment T_3 and T_4).
- In addition to this, as drying air temperature increased from 45^0 C to 50^0 C at constant air velocity of 0.50 m/s, value of drying constant also increased from 0.14 h^{-1} to 0.16 h^{-1}, respectively (i.e., treatment T_1 and T_3).

- Similarly it was observed that as drying air temperature increased from 45^0 C to 50^0 C at constant air velocity of 0.50 m/s, value of drying constant also increased from 0.15 h^{-1} to 0.17 h^{-1}, respectively (i.e., treatment T_2 and T_4).

Table 7.1 Values of drying rate and moisture ratio at different drying time for different trays at 45 ^{0}C drying air temperature and 0.50 m/s air velocity (Treatment T_1)

Sr. No.	Drying Time (IST), h	Tray 1			Tray 2			Tray 3			Tray 4			Tray 5			Tray 6		
		M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
1	9:00	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
2	10:00	13.5	0.2	0.95	13.6	0.3	0.96	13.5	0.4	0.95	13.4	0.5	0.93	13.6	0.3	0.96	13.3	0.6	0.92
3	11:00	12.6	0.9	0.87	12.9	0.7	0.90	12.68	0.82	0.88	12.7	0.7	0.90	12.8	0.8	0.89	12.4	0.9	0.87
4	12:00	11.5	1.1	0.82	11.75	1.15	0.82	11.64	1.04	0.83	11.65	1.05	0.83	11.75	1.05	0.83	11.45	0.95	0.84
5	13:00	10.34	1.16	0.77	10.51	1.24	0.76	10.58	1.06	0.79	10.5	1.15	0.78	10.64	1.11	0.79	10.22	1.23	0.75
6	14:00	9.1	1.24	0.68	9.2	1.31	0.67	9.28	1.3	0.68	9.26	1.24	0.69	9.3	1.34	0.68	9.11	1.11	0.70
7	15:00	8.05	1.05	0.60	8.05	1.15	0.57	8.13	1.15	0.59	8.2	1.06	0.62	8.15	1.15	0.59	8.21	0.9	0.66
8	16:00	7.17	0.88	0.43	7.15	0.9	0.42	7.18	0.95	0.42	7.3	0.9	0.47	7.28	0.87	0.47	7.37	0.84	0.51
9	17:00	6.52	0.65	0.03	6.6	0.55	0.15	6.65	0.67	0.22	6.7	0.6	0.25	6.79	0.49	0.37	6.85	0.52	0.40

Tray 7			Tray 8			Tray 9			Tray 10			Tray 11			Tray 12			Mean		
M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
13.5	0.4	0.95	13.7	0.2	0.97	13.7	0.2	0.97	13.3	0.6	0.92	13.21	0.69	0.91	13.48	0.42	0.94	13.48	0.40	0.94
12.8	0.7	0.90	12.75	0.95	0.87	12.9	0.8	0.89	12.42	0.88	0.87	12.25	0.96	0.86	12.49	0.99	0.86	12.64	0.84	0.88
11.73	1.07	0.83	11.68	1.07	0.83	11.85	1.05	0.84	11.42	1	0.83	11.19	1.06	0.82	11.33	1.16	0.81	11.58	1.06	0.83
10.62	1.11	0.79	10.49	1.19	0.77	10.7	1.15	0.79	10.21	1.21	0.75	9.97	1.22	0.74	10.15	1.18	0.76	10.41	1.17	0.77
9.42	1.2	0.71	9.19	1.3	0.67	9.49	1.21	0.71	8.96	1.25	0.66	8.87	1.1	0.68	8.86	1.29	0.65	9.17	1.24	0.68
8.32	1.1	0.62	8.01	1.18	0.56	8.39	1.1	0.63	7.76	1.2	0.51	7.86	1.01	0.57	7.69	1.17	0.50	8.07	1.10	0.59
7.43	0.89	0.51	7.21	0.8	0.47	7.59	0.8	0.58	6.86	0.9	0.29	7	0.86	0.37	6.81	0.88	0.26	7.20	0.87	0.43
6.72	0.71	0.24	6.61	0.6	0.15	6.84	0.75	0.31	6.5	0.36	0.00	6.54	0.46	0.08	6.54	0.27	0.13	6.66	0.55	0.20

M.C. = Moisture Content ; D.R. = Drying Rate ; MR = Moisture Ratio

Table 7.2 Values of drying rate and moisture ratio at different drying time for different trays at 45 ^{0}C drying air temperature and 1.0 m/s air velocity (Treatment T_2)

Sr. No.	Drying Time (IST), h	Tray 1			Tray 2			Tray 3			Tray 4			Tray 5			Tray 6		
		M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
1	9:00	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
2	10:00	13.5	0.2	0.95	13.6	0.3	0.96	13.5	0.4	0.95	13.4	0.5	0.93	13.6	0.3	0.96	13.3	0.6	0.92
3	11:00	12.6	0.9	0.87	12.9	0.7	0.90	12.68	0.82	0.88	12.7	0.7	0.90	12.8	0.8	0.89	12.4	0.9	0.87
4	12:00	11.5	1.1	0.82	11.75	1.15	0.82	11.64	1.04	0.83	11.65	1.05	0.83	11.75	1.05	0.83	11.45	0.95	0.84
5	13:00	10.34	1.16	0.77	10.51	1.24	0.76	10.58	1.06	0.79	10.5	1.15	0.78	10.64	1.11	0.79	10.22	1.23	0.75
6	14:00	9.1	1.24	0.68	9.2	1.31	0.67	9.28	1.3	0.68	9.26	1.24	0.69	9.3	1.34	0.68	9.11	1.11	0.70
7	15:00	8.05	1.05	0.60	8.05	1.15	0.57	8.13	1.15	0.59	8.2	1.06	0.62	8.15	1.15	0.59	8.21	0.9	0.66
8	16:00	7.17	0.88	0.43	7.15	0.9	0.42	7.18	0.95	0.42	7.3	0.9	0.47	7.28	0.87	0.47	7.37	0.84	0.51
9	17:00	6.52	0.65	0.03	6.6	0.55	0.15	6.65	0.67	0.22	6.7	0.6	0.25	6.79	0.49	0.37	6.85	0.52	0.40

Tray 7			Tray 8			Tray 9			Tray 10			Tray 11			Tray 12			Mean		
M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.91	0	1
13.6	0.3	0.96	13.65	0.25	0.97	13.3	0.6	0.92	13.2	0.7	0.91	13.1	0.8	0.89	13.45	0.45	0.94	13.48	0.43	0.94
12.9	0.7	0.90	12.75	0.9	0.87	12.4	0.9	0.87	12.42	0.78	0.88	12.18	0.92	0.86	12.47	0.98	0.86	12.65	0.83	0.88
11.8	1.1	0.83	11.65	1.1	0.82	11.34	1.06	0.82	11.38	1.04	0.82	11.06	1.12	0.80	11.45	1.02	0.83	11.56	1.09	0.82
10.56	1.24	0.77	10.38	1.27	0.75	10.08	1.26	0.74	10.1	1.28	0.74	9.83	1.23	0.73	10.29	1.16	0.77	10.35	1.20	0.76
9.2	1.36	0.67	9.04	1.34	0.65	8.64	1.44	0.60	8.84	1.26	0.65	8.67	1.16	0.65	9.01	1.28	0.66	9.07	1.29	0.66
8.06	1.14	0.58	7.89	1.15	0.55	7.52	1.12	0.48	7.87	0.97	0.59	7.6	1.07	0.51	7.9	1.11	0.56	7.98	1.09	0.57
7.27	0.79	0.49	7	0.89	0.36	6.82	0.7	0.31	6.97	0.9	0.34	6.84	0.76	0.31	6.93	0.97	0.31	7.12	0.86	0.41
6.58	0.69	0.10	6.63	0.37	0.26	6.52	0.3	0.06	6.5	0.47	0.00	6.54	0.3	0.12	6.54	0.39	0.09	6.32	0.52	0.19

M.C. = Moisture Content ; D.R. = Drying Rate ; MR = Moisture Ratio

Table 7.3 Values of drying rate and moisture ratio at different drying time for different trays at 50 ^{0}C drying air temperature and 0.50 m/s air velocity (Treatment T_3)

Sr. No.	Drying Time (IST), h	Tray 1			Tray 2			Tray 3			Tray 4			Tray 5			Tray 6		
		M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
1	9:00	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
2	10:00	13.5	0.2	0.95	13.6	0.3	0.96	13.5	0.4	0.95	13.4	0.5	0.93	13.6	0.3	0.96	13.3	0.6	0.92
3	11:00	12.6	0.9	0.87	12.9	0.7	0.90	12.68	0.82	0.88	12.7	0.7	0.90	12.8	0.8	0.89	12.4	0.9	0.87
4	12:00	11.5	1.1	0.82	11.75	1.15	0.82	11.64	1.04	0.83	11.65	1.05	0.83	11.75	1.05	0.83	11.45	0.95	0.84
5	13:00	10.34	1.16	0.77	10.51	1.24	0.76	10.58	1.06	0.79	10.5	1.15	0.78	10.64	1.11	0.79	10.22	1.23	0.75
6	14:00	9.1	1.24	0.68	9.2	1.31	0.67	9.28	1.3	0.68	9.26	1.24	0.69	9.3	1.34	0.68	9.11	1.11	0.70
7	15:00	8.05	1.05	0.60	8.05	1.15	0.57	8.13	1.15	0.59	8.2	1.06	0.62	8.15	1.15	0.59	8.21	0.9	0.66
8	16:00	7.17	0.88	0.43	7.15	0.9	0.42	7.18	0.95	0.42	7.3	0.9	0.47	7.28	0.87	0.47	7.37	0.84	0.51
9	17:00	6.52	0.65	0.03	6.6	0.55	0.15	6.65	0.67	0.22	6.7	0.6	0.25	6.79	0.49	0.37	6.85	0.52	0.40

Tray 7			Tray 8			Tray 9			Tray 10			Tray 11			Tray 12			Mean		
M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
13.5	0.4	0.95	13.7	0.2	0.97	13.7	0.2	0.97	13.3	0.6	0.92	13.21	0.69	0.91	13.48	0.42	0.94	13.48	0.40	0.94
12.8	0.7	0.90	12.75	0.95	0.87	12.9	0.8	0.89	12.42	0.88	0.87	12.25	0.96	0.86	12.49	0.99	0.86	12.64	0.84	0.88
11.73	1.07	0.83	11.68	1.07	0.83	11.85	1.05	0.84	11.42	1	0.83	11.19	1.06	0.82	11.33	1.16	0.81	11.58	1.06	0.83
10.62	1.11	0.79	10.49	1.19	0.77	10.7	1.15	0.79	10.21	1.21	0.75	9.97	1.22	0.74	10.15	1.18	0.76	10.41	1.17	0.77
9.42	1.2	0.71	9.19	1.3	0.67	9.49	1.21	0.71	8.96	1.25	0.66	8.87	1.1	0.68	8.86	1.29	0.65	9.17	1.24	0.68
8.32	1.1	0.62	8.01	1.18	0.56	8.39	1.1	0.63	7.76	1.2	0.51	7.86	1.01	0.57	7.69	1.17	0.50	8.07	1.10	0.59
7.43	0.89	0.51	7.21	0.8	0.47	7.59	0.8	0.58	6.86	0.9	0.29	7	0.86	0.37	6.81	0.88	0.26	7.20	0.87	0.43
6.72	0.71	0.24	6.61	0.6	0.15	6.84	0.75	0.31	6.5	0.36	0.00	6.54	0.46	0.08	6.54	0.27	0.13	6.66	0.55	0.20

Table 7.4 Values of drying rate and moisture ratio at different drying time for different trays at 50 ^{0}C drying air temperature and 1.0 m/s air velocity (Treatment T_4)

Sr. No.	Drying Time (IST), h	Tray 1			Tray 2			Tray 3			Tray 4			Tray 5			Tray 6		
		M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
1	9:00	13.9	0	1.00	13.9	0	1.00	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
2	10:00	13.6	0.2	0.96	13.7	0.2	0.97	13.56	0.34	0.95	13.49	0.41	0.94	13.68	0.22	0.97	13.48	0.42	0.94
3	11:00	12.7	0.9	0.87	12.8	0.9	0.88	12.73	0.83	0.88	12.86	0.63	0.91	12.74	0.94	0.87	12.53	0.95	0.86
4	12:00	11.54	1.16	0.81	11.79	1.01	0.84	11.68	1.05	0.83	11.79	1.07	0.83	11.68	1.06	0.83	11.46	1.07	0.82
5	13:00	10.34	1.2	0.76	10.7	1.09	0.79	10.53	1.15	0.78	10.68	1.11	0.79	10.59	1.09	0.79	10.23	1.23	0.75
6	14:00	9.09	1.25	0.67	9.47	1.23	0.71	9.28	1.25	0.69	9.34	1.34	0.68	9.38	1.21	0.70	9.07	1.16	0.69
7	15:00	8.05	1.04	0.60	8.32	1.15	0.61	8.15	1.13	0.59	8.25	1.09	0.62	8.18	1.2	0.58	8.16	0.91	0.65
8	16:00	7.15	0.9	0.42	7.4	0.92	0.49	7.26	0.89	0.46	7.29	0.96	0.45	7.26	0.92	0.45	7.3	0.86	0.48
9	17:00	6.53	0.62	0.05	6.79	0.61	0.32	6.59	0.67	0.12	6.58	0.71	0.10	6.8	0.46	0.39	6.75	0.55	0.31

Tray 7			Tray 8			Tray 9			Tray 10			Tray 11			Tray 12			Mean		
M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR	M.C. %(wb)	D.R. (%/h)	MR
13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1	13.9	0	1
13.54	0.36	0.95	13.21	0.69	0.91	13.19	0.71	0.90	13.08	0.82	0.89	13.42	0.48	0.94	13.52	0.38	0.95	13.46	0.44	0.94
12.86	0.68	0.90	12.32	0.89	0.87	12.26	0.93	0.86	12.1	0.98	0.85	12.54	0.88	0.87	12.54	0.98	0.86	12.58	0.87	0.87
11.71	1.15	0.82	11.3	1.02	0.82	11.14	1.12	0.81	11.03	1.07	0.81	11.45	1.09	0.82	11.48	1.06	0.82	11.50	1.08	0.82
10.52	1.19	0.77	10.22	1.08	0.78	10	1.14	0.75	9.95	1.08	0.76	10.35	1.1	0.78	10.38	1.1	0.78	10.37	1.13	0.77
9.29	1.23	0.69	9.05	1.17	0.69	8.75	1.25	0.64	8.73	1.22	0.65	9.12	1.23	0.68	9.02	1.36	0.65	9.13	1.24	0.68
8.2	1.09	0.61	8.04	1.01	0.60	7.65	1.1	0.51	7.61	1.12	0.50	8	1.12	0.57	7.84	1.18	0.53	8.04	1.10	0.58
7.29	0.91	0.46	7.19	0.85	0.45	6.89	0.76	0.34	6.89	0.72	0.35	7.03	0.97	0.35	6.96	0.88	0.34	7.16	0.88	0.42
6.69	0.6	0.24	6.61	0.58	0.16	6.56	0.33	0.15	6.55	0.34	0.13	6.54	0.49	0.08	6.54	0.42	0.09	6.63	0.53	0.18

M.C. = Moisture Content ; D.R. = Drying Rate ; MR = Moisture Ratio

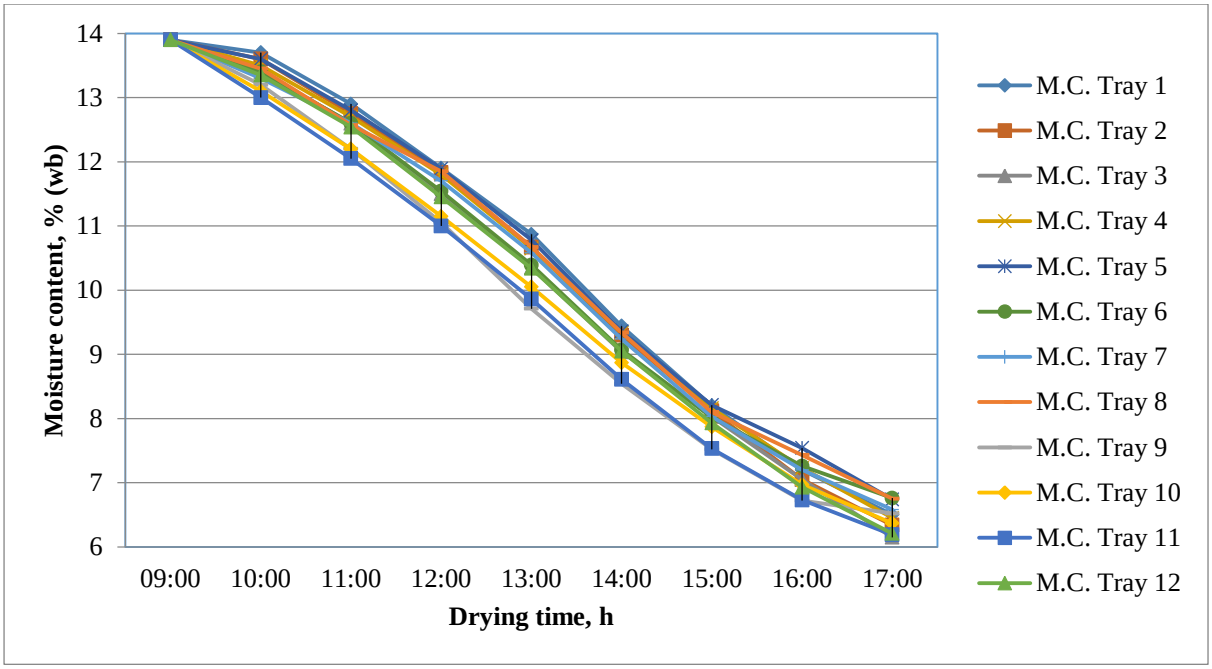


Fig. 7.1 Relationship between drying time and moisture content for treatment T_1

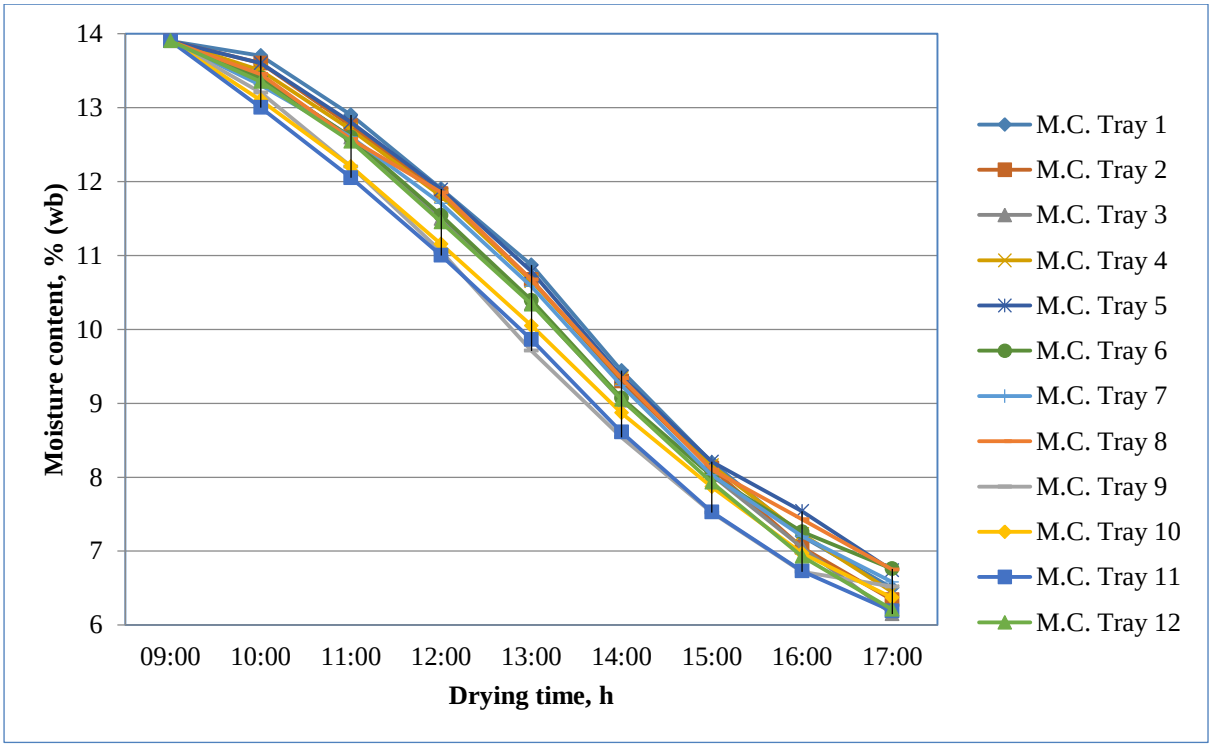


Fig. 7.2 Relationship between drying time and moisture content for treatment T_2

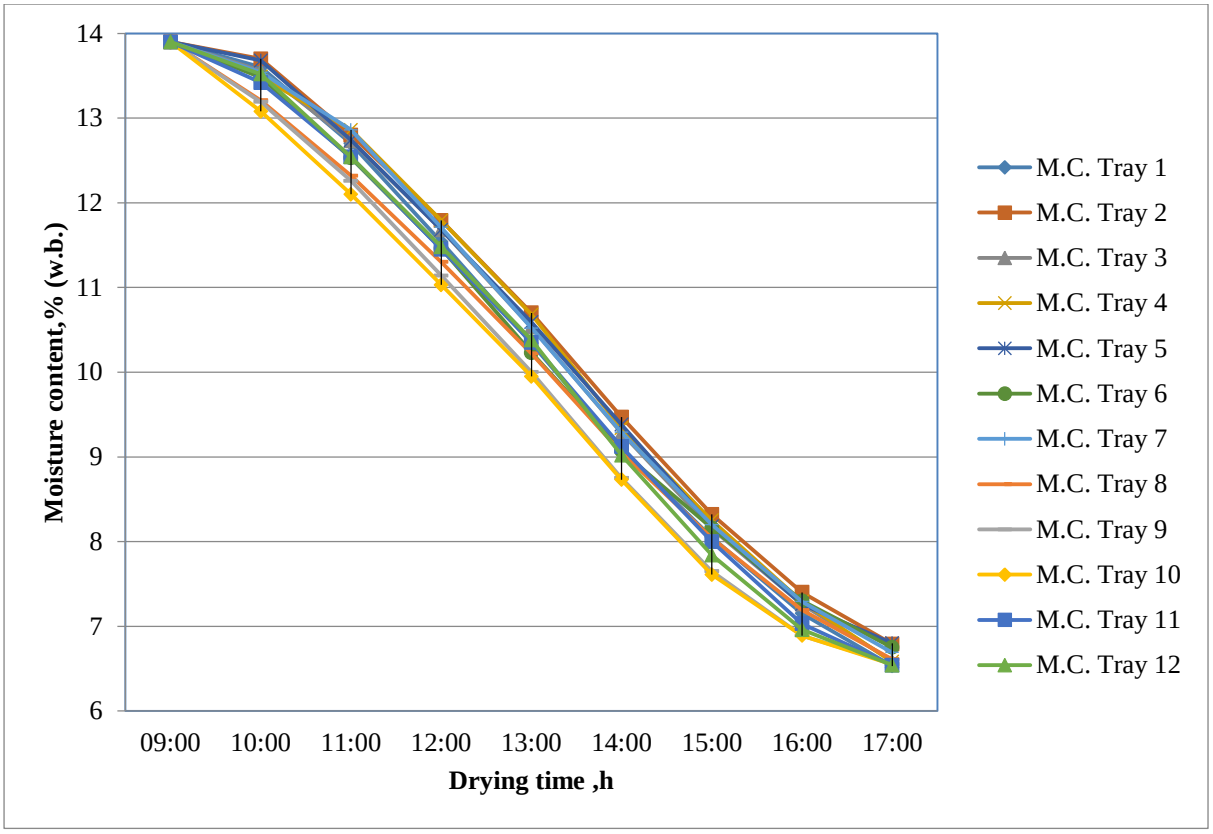


Fig. 7.3 Relationship between drying time and moisture content for treatment T_3

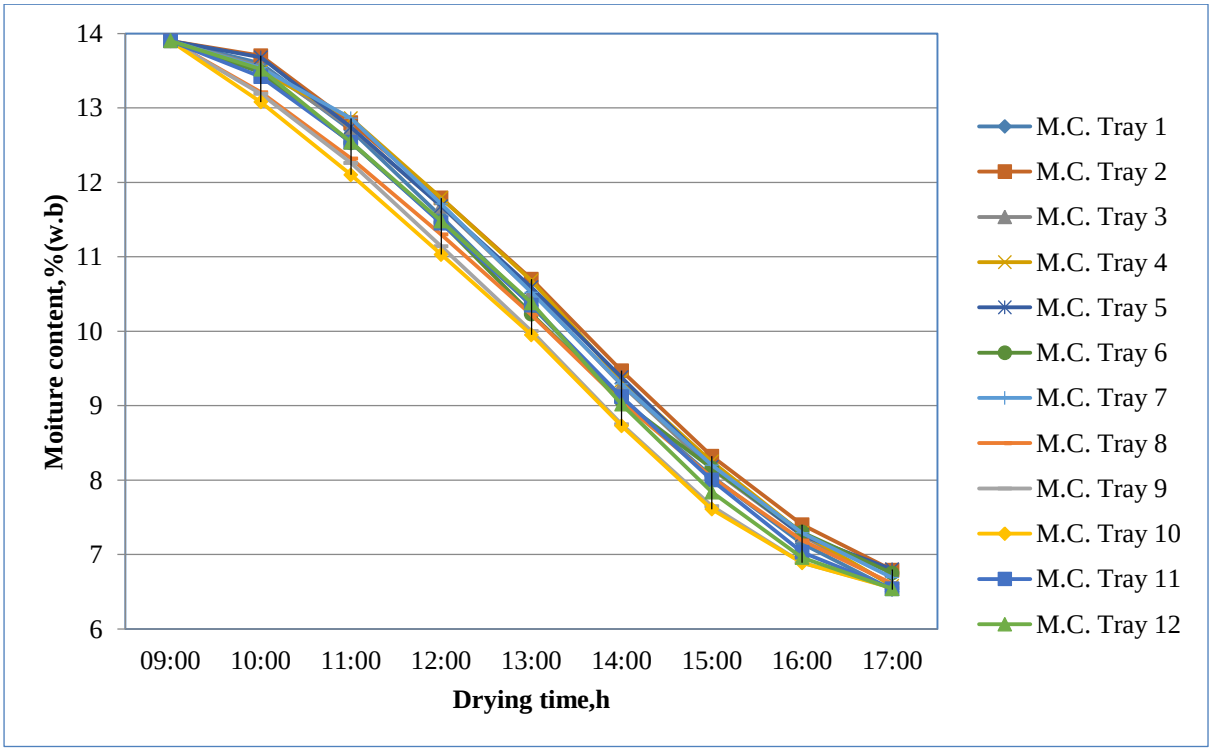


Fig. 7.4 Relationship between drying time and moisture content for treatment T_4

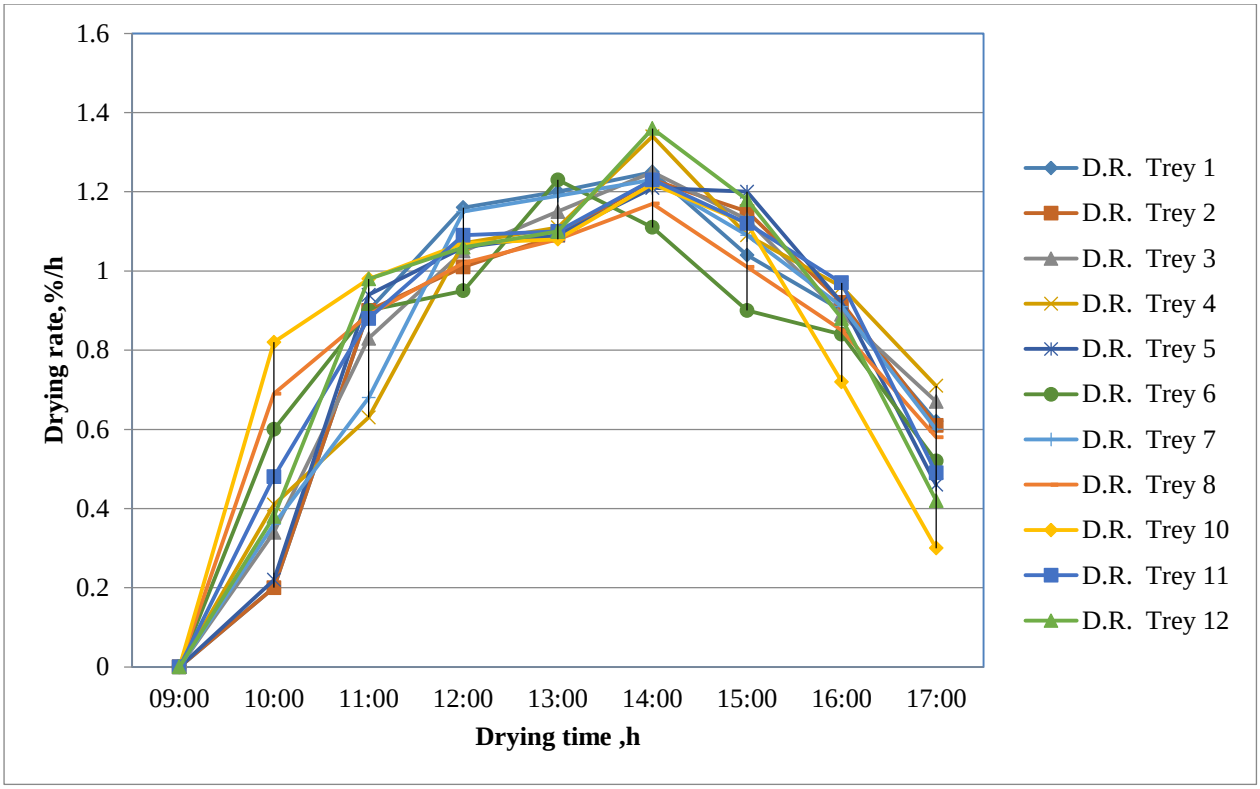


Fig. 7.5 Relationship between drying time and drying rate for treatment T_1

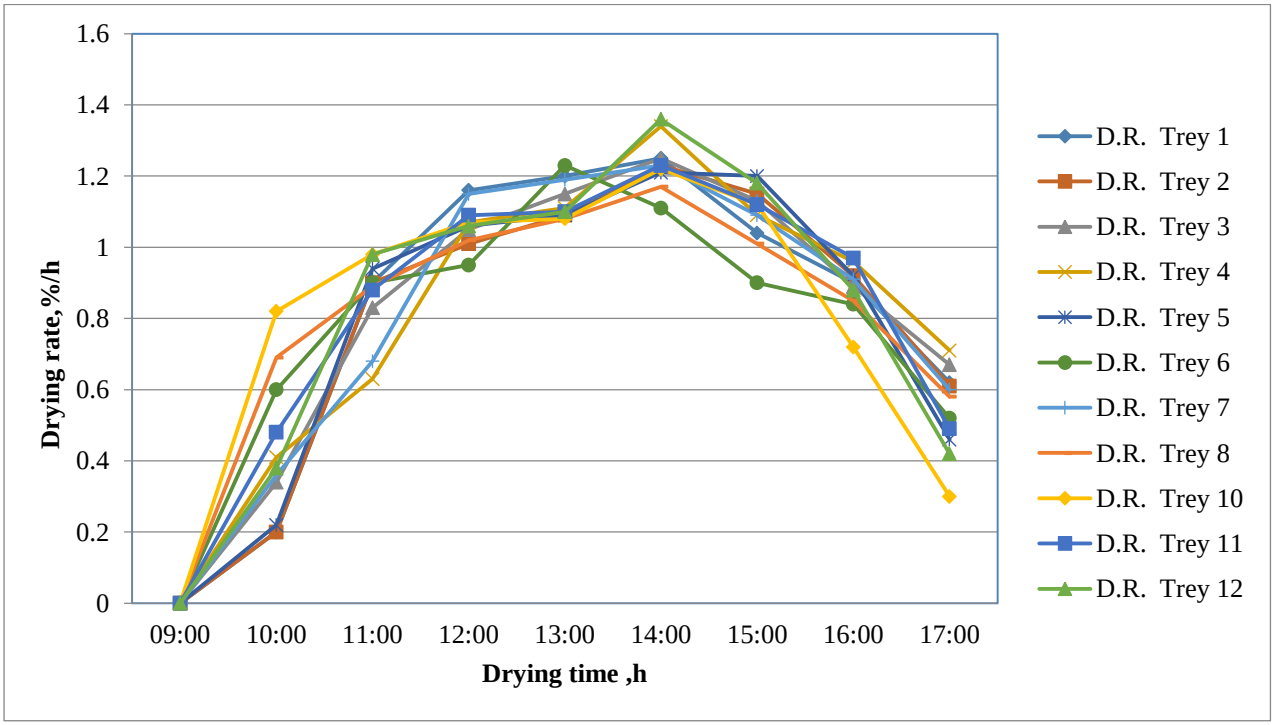


Fig. 7.6 Relationship between drying time and drying rate for treatment T_2

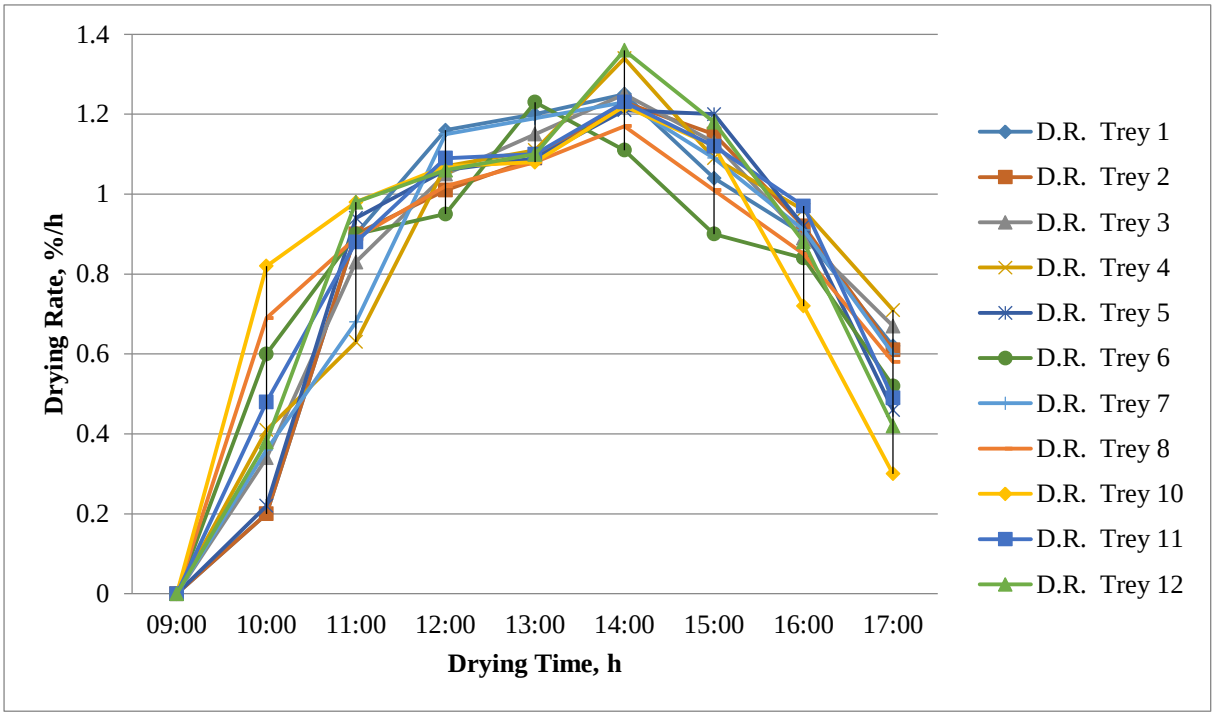


Fig. 7.7 Relationship between drying time and drying rate for treatment T_3

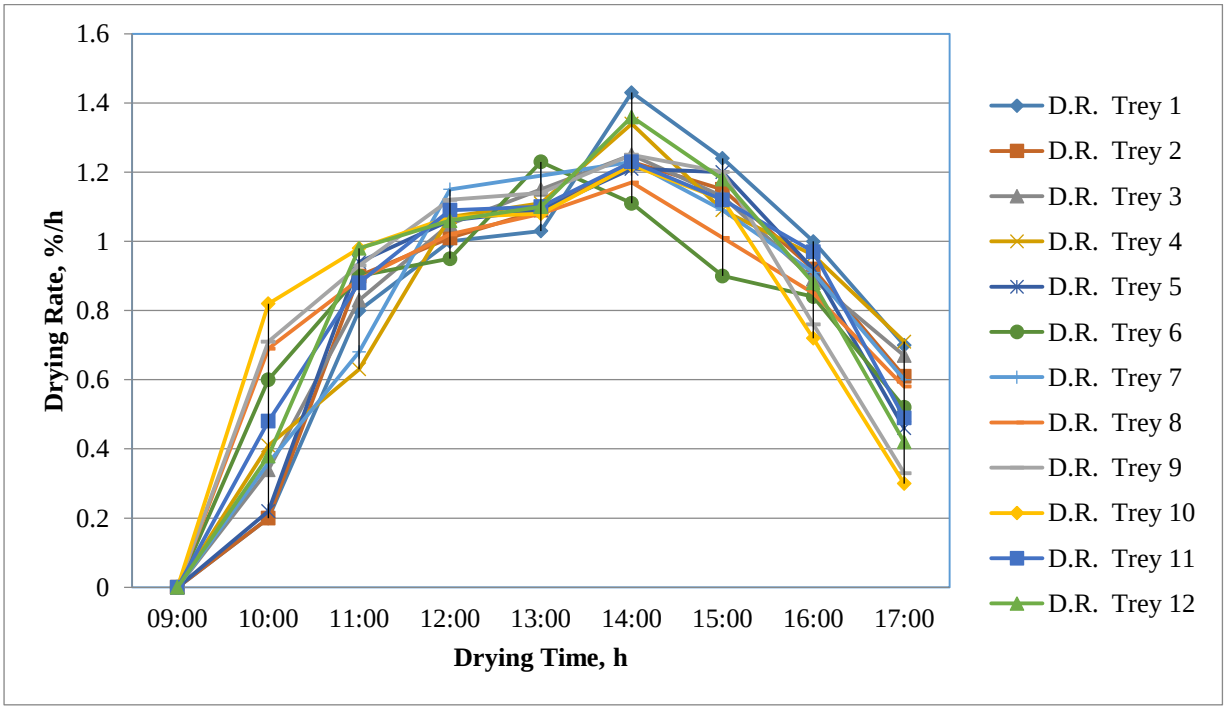


Fig. 7.8 Relationship between drying time and drying rate for treatment T_4

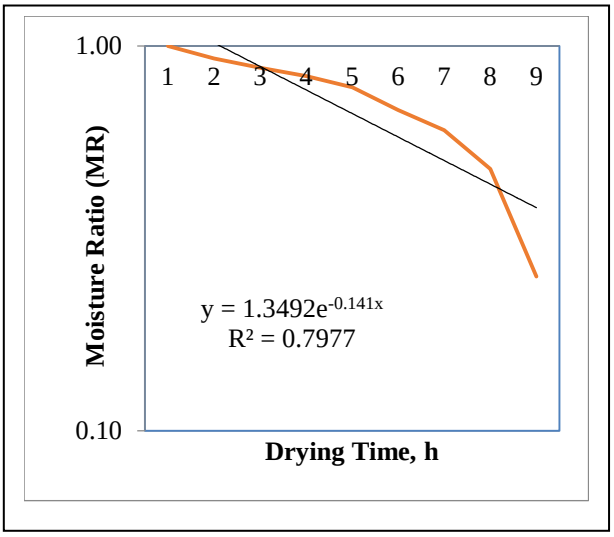


Fig. 7.9 Relationship between drying time and MR for treatment T_1

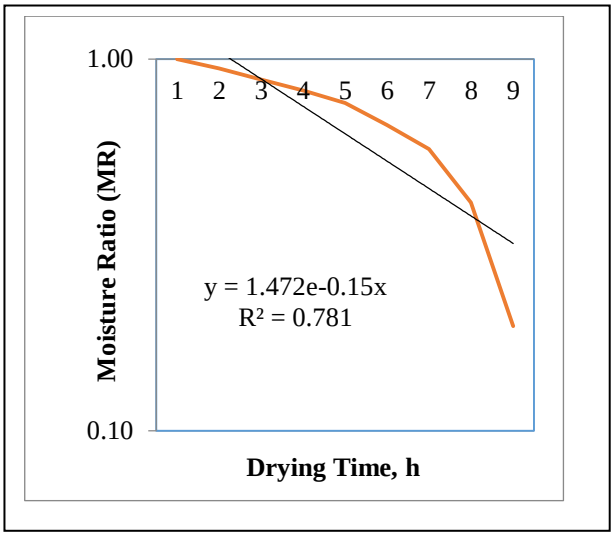


Fig. 7.10 Relationship between drying time and MR for treatment T_2

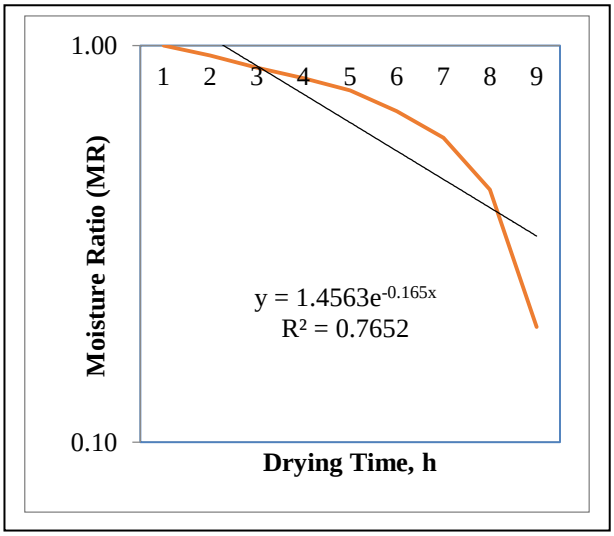


Fig. 7.11 Relationship between drying time and MR for treatment T_3

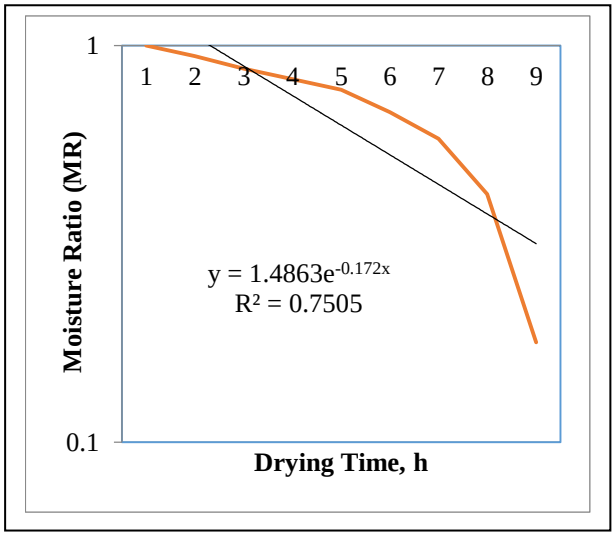


Fig. 7.12 Relationship between drying time and MR for treatment T_4

Table 7.5 Effect of drying method and packaging material on pod damage (%), moisture content (%(wb), germination (%) and pest population build up after 7th month of storage.

Treatments	Pest population build up (Adult of Bruchid beetle) during storage of groundnut	Pod damage on weight basis, (%)	Moisture content, % (wb)	% Germination after 7th month of storage
Effect of Drying Method (D)				
D_1	2.199 (4.34)	44.468 (49.07)	8.033	72.808 (91.26)
D_2	2.296 (4.77)	45.738 (51.29)	8.175	73.513 (91.95)
SEM +	0.0440	0.3445	0.0120	0.4877
CD at 5 %	NS	0.9979	0.0346	NS
Effect of Packaging Material (P)				
P_1	2.226 (4.46)	49.317 (57.51)	8.773	74.406 (92.77)
P_2	2.445 (5.48)	52.051 (61.18)	7.947	73.152 (91.60)
P_3	2.547 (5.99)	53.948 (71.19)	7.659	73.037 (91.49)
P_4	2.639 (6.46)	57.536 (71.19)	7.505	70.215 (88.54)
P_5	1.403 (1.47)	18.405 (9.97)	6.948	76.776 (94.77)
P_6	1.618 (2.12)	24.317 (16.96)	9.092	75.325 (93.58)
P_7	2.855 (7.65)	60.147 (75.22)	8.805	69.215 (87.41)
SEM +	0.0823	0.6445	0.0224	0.9123
CD at 5 %	0.2383	1.8668	0.0648	2.6424
Effect of Interaction between Drying Method (D) and Packaging Material (D x P)				
D_1P_1	2.20 (4.34)	49.03 (57.01)	8.70	74.07 (92.47)
D_1P_2	2.41 (5.31)	51.56 (61.35)	7.89	72.23 (90.69)
D_1P_3	2.48 (5.65)	53.33 (65.36)	7.59	73.17 (91.62)
D_1P_4	2.54 (5.95)	57.01 (75.22)	7.41	69.77 (88.04)
D_1P_5	1.34 (1.30)	18.08 (9.63)	6.90	75.91 (94.07)
D_1P_6	1.56 (1.93)	23.55 (15.96)	9.01	74.74 (93.07)
D_1P_7	2.85 (7.62)	58.72 (73.04)	8.72	69.77 (88.04)
D_2P_1	2.26 (4.61)	49.61 (58.01)	8.85	74.74 (93.07)
D_2P_2	2.48 (5.65)	52.54 (63.01)	8.00	74.07 (92.47)
D_2P_3	2.61 (6.31)	54.56 (66.38)	7.72	72.90 (91.35)
D_2P_4	2.73 (6.95)	58.06 (72.01)	7.60	70.67 (89.04)
D_2P_5	1.46 (1.63)	18.73 (10.31)	7.00	77.64 (95.42)
D_2P_6	1.68 (2.32)	25.08 (17.97)	9.17	75.91 (94.07)
D_2P_7	2.86 (7.68)	61.58 (77.35)	8.89	68.66 (86.76)
SEM +	0.1164	0.9115	0.0316	1.2902
CD at 5 %	NS	NS	NS	NS
CV %	8.97	3.50	0.68	3.05

Table 7.5 revealed that effect of drying method (D) after 7th month of storage on adult pest population build up and germination (%) was found not significant, however effect on pod damage (%) and moisture content (%(wb)) was found significant. It was also observed that the effect of packaging materials (P) after 7th month of storage on adult pest population build up, pod damage (%),moisture content (%(wb)) and germination (%) was found significant. In addition to these, solar drying was found slightly superior as compared to traditional after 7th month of storage on the basis of adult pest population build up, pod damage (%),moisture content (%(wb)) and germination (%).

Table 7.5 also revealed that interaction of drying method (D) and packaging materials (P), i.e., D x P after 7th month of storage on adult pest population build up, pod damage (%),moisture content (%(wb)) and germination (%) was found non-significant.

Table 7.6 and 7.7 revealed that the level of aflatoxin 11.4 ppb was found ground pods before sun and solar drying methods were completely eliminated in groundnut pods after both the drying methods.

Table 7.6 Total aflatoxin percentage in groundnut dried by *solar* drying method

Sr. No.	Treatment	Total aflatoxin percentage Initial	Total aflatoxin percentage after 7month HPLC method	Remark: Permissible level of aflatoxin
1	PICS bags (Perdue improve crop storage bag)	11.4ppb Before solar drying of groundnut	Absent	1. 4ppb in European union. 2. 20ppb in USA 3. ppb for Agmark standards in India
2	Closely woven net bags		Absent	

Table 7.7 Total aflatoxin percentage in groundnut dried by sun drying method

Sr. No.	Treatment	Total aflatoxin percentage Initial LCMS-QTOF method	Total aflatoxin percentage at storage time LCMS-QTOF method	Total aflatoxin percentage after 7month HPLC method	Remark: Permissible level of aflatoxin
1	PICS bags (Perdue improve crop storage bag)	11.4ppb Before sun drying of g'nut	Below limit After sun drying of groundnut	Absent	1. 4ppb in European union. 2. 20ppb in USA 3. ppb for Agmark standards in India
2	Closely woven net bags			Absent	

8. Output During Period Under Report

a. Special attainments/innovations

b. List of Publications (one copy each to be submitted with RPP-II)

i. Research papers

1. Cholera, S. P.; Dabhi, M. N.; Joshi, A. M.; Sarsavadia, P. N.; Rathod, P. J. & Dhudesiya, R. D. Design and Development of on Farm Solar Dryer For Drying of Ground Nut Pods For Longer Storage. "AGRES - An International e. Journal" Volume : 7(1). 80-102. 2018.
2. Cholera, S. P.; Chudasama, S. A.; Gelani, K. A. & Sanghani, J. O. Solar Drying of Groundnut Pods: Better Alternative to Traditional Drying Method. "AGRES - An International e. Journal" Volume : 7(1). 39-**53**. 2018.

ii. Reports/Manuals

iii. Working and Concept Papers

iv. Popular articles

v. Books/Book Chapters

vi. Extension Bulletins

c. Intellectual Property Generation
(Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any)

d. Presentation in Workshop/Seminars/Symposia/Conferences
(relevant to the project in which scientists have participated)

1. Solar Dryer for Groundnut Pods Drying. National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, April, 2018, ICAR-DGR, Junagadh.
2. Drying Characteristics of Groundnut Pods By Solar Dryer. National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, April, 2018, ICAR-DGR, Junagadh.

e. Details of technology developed
(Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)

f. Trainings/demonstrations organized

g. Training received

h. Any other relevant information

9. Constraints experienced, if any

10. Lessons Learnt

11. Evaluation

(a) Self evaluation of the project for the period under report by the PI with rating in the scale of 1 to 10 ☐

(b) Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10

12. Signature of PI, CC-PI(s), all Co-PIs

13. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section

14. Comments of IRC

15. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director

Project – 1

Value Chain on Groundnut

Investigation No. : 2

ANNEXURE -VI

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF FINAL RESEARCH PROJECT REPORT (RPP-III)

(For Guidelines Refer ANNEXURE – XI (F))

1. Institute Project Code:PH/JU/2016/01/02 To study the effect of different packing materials against Groundnut Bruchid (*Caryedon serratus* Olivier.) during storage
2. Investigators as approved in RPP-I, If any change attach IRC proceedings: NO

Principal Investigator	CC-PI	Co-PI
R.D. Dhudashia Assistant Entomologist	A.M. Joshi, Assistant Microbiologist	Dr. M. N. Dabhi, Research Engineer

3. Any change in objectives and activities : No
   (If yes, attach IRC proceedings)

4.	Date of Start & Date of Completion (Actual). If any extension granted enclose IRC proceedings			No
5.	Whether all objectives met		Yes	
6.	All activities completed		Yes	
7.	Salient achievements/major recommendations included		Yes	
8.	Annual Progress Reports (RPP-II) submitted	1st Year	Yes	
		2nd Year	Yes	

		3rd Year	NA	
		4th year	NA	
9.	Reprint of each of publication attached		Yes	No
10.	Action for further pursuit of obtained results indicated		Yes	No
11.	Report presented in Divisional seminar (enclose proceedings & action taken report)		Yes	No
12.	Report presented in Institute seminar (enclose proceedings & action taken report)		Yes	No
13.	IRC number in which the project was adopted		IRC No:	
14.	Any other Information			

15. Signature:

Project Leader Co-PI Co-PI Co-PI

HOD/PD/I/c.

ANNEXURE – VII

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

FINAL RESEARCH PROJECT REPORT (RPP- III)

(For Guidelines Refer ANNEXURE – XI(G))

PROJECT REPORT (RPP- III)

1. Institute Project Code : PH/JU/2016/01/02

2. To study the effect of different packing materials against Groundnut Bruchid (*Caryedon serratus* Olivier.) during storage

3. Key Words: Groundnut Storage, Bruchid beetle, Packing materials

4. (a) Name of the Lead Institute: College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

(b) Name of Division/ Regional Center/ Section: AICRP on PHET, Junagadh centre

5. (a) Name of the Collaborating Institute(s)

(b) Name of Division/ Regional Center/ Section of Collaborating Institute(s)

6. Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time spent)

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	R.D.Dhudashia Assistant Entomologist,	PI	60%	planning, data collection, statistical analysis and final

	AICRP on PHET, Junagadh center			report Writing
2.	A.M.Joshi, Assistant Microbiologist, AICRP on PHET, Junagadh center	Co-PI	20%	Helping in analysis and data collection
3.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Junagadh center	Co-PI	20%	Supervision and Co-ordination

7. Priority Area: Post Harvest Technology

8. Project Duration: Date of Start : March-2016 Date of Completion : December, 2018

9. (a) Objectives

1. **To study insect infestation and its damage to pods in different packing materials in stored groundnut**
2. **To evaluate the effect of packing materials on germination of seeds of groundnut during storage.**
3. To study on moisture content and aflatoxin level in different packing materials for safe storage of groundnut

(b) Practical utility

- For safe storage of groundnut, effective storage bag against bruchid infestation will be find out.
- Losses during storage will be reduced
- Farmer will get more market price
- Farmers will store groundnut without using any hazardous chemicals
- This technology is safe to environment.

10. Final Report on the Project (materials and methods used, results and discussion, objective wise achievements and conclusions)

1.	**Title of Experiment**	**:**	To study the effect of different packing materials against Groundnut Bruchid (*Caryedon serratus* Olivier.) during storage.
2.	**Tech. Programme approved in AICRP**	**:**	31th AICRP-PHET workshop
3.	**Background information**	**:**	
	Groundnut is an important oilseed crop in India. Groundnut when stored is often attacked by groundnut bruchid. Groundnut bruchid (*Caryedon serratus* Olivier.) is one of the major and important storage insect species, causing loss in weight and quality of pods. Bruchid infestation reduces the market value and germination of seeds. Hence farmers have		

	a problem for storing of groundnut. Various scientists were tested different packing materials for minimizing storage losses of groundnut. However, Very little information is available on pest incidence in different packing materials during storage of groundnut. Thus, it is necessary to find out the effective packing materials for safe storage of groundnut.				
4.	**Objectives**				
	1. **To study insect infestation and its damage to pods in different packing materials in stored groundnut** 2. **To evaluate the effect of packing materials on germination of seeds of groundnut during storage.** 3. To study on moisture content and aflatoxin level in different packing materials for safe storage of groundnut.				
5.	**Location and agro climatic Zone**	**:**	Department of Processing and Food Engineering College of Agricultural Engineering & Technology,Junagadh Agricultural University, Junagadh, South Saurashtra Agro-climatic Zone		
6.	**Investigators (PI, Co-PI & Associate)**	**:**	(1)Prof.R.D.Dhudashia, Associate Research Sci. (2)Dr.M.N.Dabhi , Research Engineer, PHET (3)Prof.A. M. Joshi, Assistant Res. Sci. (4)Prof.D.M.Vyas, Prof. & Head, PFE Dept.		
7.	**Experimental Season & years**	**:**	2016-17 and 2017-18		
8.	**Crop and variety**	**:**	Groundnut, GG-20		
9.	**Year wise cultural practices**	**:**	**2016-17**	**2017-18**	
	(a) Date of installation	**:**	21th Dec.2016	18th Dec.2017	
	(b) Date of trial end	**:**	24th July,2017	18th July,2018	
10.	**Experimental details**	**:**			
	a .	**Treatments**	**:**	**7 (seven)**	
	Sr. No.	**Treatment**			
	1	Jute bags			
	2	HDPE bags(empty fertilizer bag)			
	3	Inner polyethylene lined jute bags			
	4	Inner polyethylene lined HDPE(fertilizer bag) bags			
	5	PICS bags (Perdue improved crop storage bag)			
	6	Closely woven net bags			
	7	Cloth bags			
	b.	**Design**	**:**	CRD	
	c.	**Replications**	**:**	3	

	d.	**Bag filling**	**:**	30 kg/bag
11.	**Methodology**		**:**	
	Well dried groundnut procured from farmer in kharif season. 30 kg pods were stored in different bags and kept at room temperature in laboratory. Initial Observation viz, moisture content, germination percent and insect infestation, damage etc. were recorded at time of storage. Monthly observations were recorded on entomological and physical parameters during storage. The observations were recorded from groundnut samples of 200 g.			

12.	**Observations recorded**	**:**	
	(A) Entomological Parameters: i. Pest population ii. Percent pods damage on number and weight base (B) Physical parameters i. Germination percentage ii Moisture percentage (C) Microbial parameters i Aflatoxin percentage		
13.	**Results, Interpretation and economics**	**:**	As per Table 1 to 8

Initial Observation At time of storage:

	Year 2017	**Year 2018**
Moisture content of pods	8.10%	8.28%
Germination percent:	98.00%	98.00%
Insect infestation:	Nil	Nil

Pest population: The pooled data (table 1 and 2) showed that pest population (no. of pupa and adult) was found after 4th month of storage and increase up to seventh month storage. No.of pupa and adult was found significant after four, five, six and seven months of storage. The minimum pupa and adult were recorded in the treatment of PICS bags after four, five, six and seven months of storage as compared to other treatments. Treatments Closely woven net bags were found next best treatment for lower pest population.

Pod damage: The pooled data in Table 3 and 4 showed that damaged percent of pod due to insect infestation (on number base) was found significant after four, five, six and seven months of storage. The minimum pod damage was found in the treatment of PICS bags after four, five, six and seven months of storage as compared to other treatments. Treatments Closely woven net bags were found next best treatment for lower pod damage.The maximum pod damage was found in Cloth bags treatment after five, six and seven months of storage. Similar results were also recorded on weight base pods damage.

Moisture percent: The pooled data in Table 5 showed that percent moisture content of pod was found was significant after five, six and seven months of storage. The percent moisture content of pod was increase up to seventh month storage which may be due to insect infestation and increase of humidity in weather. The minimum percent moisture content of pod was found in the treatment of Closely woven net bags after five, months of storage, which may be due to winter effect on net packing. The maximum percent moisture

	content of pod was found in closely woven net bags after six and seven months of storage, which may be due increase of humidity in weather. whereas minimum percent moisture content of pod was found in treatment of PICS bag after six and seven months of storage. **Germination percent:** The pooled data (table No.6) showed that germination percent was found significant after seven month of storage. The maximum germination percent was found in PICS bag treatment after seven months of storage which may be due to low insect infestation. Closely woven net bag treatment was found next best treatment for germination after seven month of storage. Whereas minimum germination percent was found in treatment of cloth bag and inner polyethylene lined HDPE bags after seven months of storage. Germination percent was slightly decreased after seven months of storage, which may be due to insect infestation and storage time. **Economics:** Looking to the economics of different storage bags (Table-7) the highest ICBR(1:10.48) was obtained in the treatment of PICS bag (Perdue improved crop storage bag) followed by treatment of Closely woven net bags(1:10.39)as compared to traditional method(Jute bag)		
14.	**Conclusion**	**:**	
	Considering the data of pest population and percent grain damage, moisture content and germination percent, the treatment of PICS bag was found the most effective to protect the groundnut pods from infestation of bruchid beetle up to 6 month of storage. The treatment of closely woven net bags was found next best treatment for storage of groundnut .		
15.	**Recommendation for farmers**	**:**	
	Farmers are advised to store the well dried groundnut pods in PICS bag (Perdue improved crop storage bag) or a Closely woven net bag was found more effective and economical management of bruchid pest.		

Table No.1: Pest populations build up (Pupa of Bruchid beetle) during storage of groundnut

Sr. No.	Treatments	Av.No.of Pupa/ 200gram sample											
		After 4 month			After 5 month			After 6 month			After 7 month		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T1	Jute bags	1.56* (1.93)**	1.86 (2.95)	1.71 (2.42)	3.53 (11.96)	3.38 (10.94)	3.46 (11.47)	3.66 (12.92)	4.14 (16.63)	3.90 (14.71)	5.48 (29.49)	5.05 (24.97)	5.26 (27.17)
T2	HDPE bags	1.17 (0.87)	2.34 (4.97)	1.75 (2.56)	3.42 (11.0)	3.72 (13.33)	3.57 (12.24)	3.85 (14.31)	4.52 (19.97)	4.19 (17.06)	5.42 (28.88)	5.34 (27.99)	5.38 (28.44)
T3	Inner polyethylene lined jute bags	0.71 (0.00)	2.46 (5.55)	1.58 (2.00)	3.41 (11.10)	3.98 (15.31)	3.69 (13.12)	3.65 (12.83)	4.45 (19.32)	4.05 (15.90)	5.20 (26.56)	5.46 (29.28)	5.33 (27.91)
T4	Inner polyethylene linedHDPEbags	1.00 (0.50)	2.61 (6.33)	1.81 (2.78)	3.15 (9.45)	4.33 (18.28)	3.74 (13.49)	5.14 (25.90)	4.74 (21.99)	4.94 (23.90)	5.51 (29.91)	5.64 (31.33)	5.58 (30.64)
T5	PICSbags (Perdueimproved cropstorage bag)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	1.68 (2.31)	1.68 (2.31)	1.68 (2.32)	2.00 (3.50)	2.26 (4.59)	2.13 (4.04)	2.34 (4.97)	2.54 (5.93)	2.44 (5.45)
T6	Closely woven net bags	0.71 (0.00)	1.17 (0.87)	0.94 (0.38)	1.66 (2.24)	2.34 (4.97)	2.06 (3.74)	2.30 (4.80)	2.97 (8.31)	2.64 (6.47)	3.47 (11.56)	3.34 (10.63)	3.40 (11.06)
T7	Cloth bags	1.95 (3.32)	2.86 (7.66)	2.41 (5.31)	4.09 (16.21)	4.30 (17.96)	4.19 (17.06)	6.90 (47.11)	4.91 (23.65)	5.91 (34.43)	7.55 (56.49)	6.09 (36.64)	6.82 (46.01)
	T												
	S. Em ±	0.17	0.15	0.33	0.24	0.13	0.22	0.30	0.12	0.50	0.24	0.13	0.30

	CD at 5%	0.50	0.47	1.15	0.72	0.39	0.76	0.92	0.38	1.72	0.73	0.38	1.03
	CV%	25.67	13.39	17.79	13.69	6.52	10.33	13.43	5.38	10.17	8.32	4.59	6.80
	Y												
	S. Em ±			0.18			0.12			0.26			0.16
	CD at 5%			0.62			0.41			NS			NS
	T x Y												
	S. Em ±			0.16			0.19			0.23			0.19
	CD at 5%			0.46			0.55			0.67			0.56

* √x+0.5 transformation value; **figure in parenthesis are retransformed value

Table No.2: Pest population build up (Adult of Bruchid beetle) during storage of groundnut

Sr. No.	Treatments	Av.No.of Adult/ 200gram sample											
		After 4 month			After 5 month			After 6 month			After 7 month		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T1	Jute bags	1.00* (0.50)**	1.05 (0.61)	1.03 (0.56)	1.86 (2.95)	1.76 (2.60)	1.81 (2.78)	2.11 (3.96)	2.11 (3.96)	2.11 (3.95)	2.40 (5.27)	2.26 (4.59)	2.33 (4.93)
T2	HDPE bags	0.71 (0.00)	1.17 (0.87)	0.94 (0.38)	1.77 (2.65)	1.86 (2.95)	1.82 (2.81)	1.93 (3.23)	2.20 (4.32)	2.06 (3.74)	2.34 (4.97)	2.48 (5.63)	2.41 (5.31)
T3	Inner polyethylene	0.71	1.34	1.03	1.17	2.18	1.68	1.86	2.40	2.13	2.11	2.61	2.36

	lined jute bags	(0.00)	(1.31)	(0.56)	(0.87)	(4.25)	(2.32)	(2.95)	(5.27)	(4.04)	(3.96)	(6.33)	(5.07)
T4	Inner polyethylene linedHDPEbags	0.71 (0.00)	1.56 (1.93)	1.13 (0.78)	1.34 (1.31)	2.34 (5.00)	1.84 (2.89)	2.04 (3.65)	2.54 (5.97)	2.29 (4.74)	2.27 (4.66)	2.73 (6.98)	2.50 (5.75)
T5	PICSbags (Perdueimproved cropstorage bag)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	1.00 (0.50)	0.85 (0.22)	0.88 (0.27)	1.34 (1.31)	1.11 (0.73)	1.56 (1.93)	1.46 (1.64)	1.51 (1.78)
T6	Closely woven net bags	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	1.17 (0.87)	0.94 (0.38)	1.46 (1.64)	1.58 (2.00)	1.52 (1.81)	2.18 (4.25)	1.68 (2.31)	1.93 (3.22)
T7	Cloth bags	1.46 (1.64)	1.68 (2.31)	1.57 (1.96)	2.27 (4.66)	2.26 (4.63)	2.27 (4.65)	2.60 (6.28)	2.48 (5.63)	2.54 (5.95)	3.43 (11.26)	2.86 (7.66)	3.14 (9.36)
	T												
	S. Em ±	0.12	0.15	0.17	0.13	0.20	0.23	0.16	0.12	0.10	0.16	0.12	0.21
	CD at 5%	0.36	0.45	0.59	0.39	0.61	0.79	0.47	0.36	0.29	0.49	0.36	0.74
	CV%	24.05	21.78	22.87	15.99	19.32	18.27	14.72	9.94	12.28	12.00	9.00	10.63
	Y												
	S. Em ±			0.09			0.12			0.05			0.11
	CD at 5%			0.31			0.42			0.15			NS
	T x Y												
	S. Em ±			0.13			0.17			0.14			0.14
	CD at 5%			0.39			0.49			NS			0.41

* √x+0.5 transformation value; **figure in parenthesis are retransformed value

Table No. 3: Percent pod damage (On number base) during storage of groundnut due to Bruchid

Sr. No.	Treatments	% pods Damage on number base											
		After 4 month			After 5 month			After 6 month			After 7 month		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T1	Jute bags	9.36* (2.64)**	12.88 (4.97)	11.12 (3.72)	17.44 (8.98)	27.00 (20.61)	22.22 (14.30)	29.99 (24.98)	40.98 (43.00)	35.48 (33.69)	55.56 (68.01)	49.61 (58.00)	52.58 (63.08)
T2	HDPE bags	6.54 (1.30)	13.73 (5.63)	10.13 (3.09)	16.74 (8.29)	26.74 (20.24)	21.74 (13.72)	29.54 (24.30)	40.59 (42.33)	35.06 (33.00)	51.75 (61.67)	52.54 (63.01)	52.15 (62.35)
T3	Inner polyethylene lined jute bags	3.83 (0.45)	15.32 6.98)	9.57 (2.76)	15.32 (6.98)	27.26 (20.98)	21.29 (13.18)	26.53 (19.96)	43.47 (47.33)	35.00 (32.90)	48.26 (55.67)	54.56 (66.38)	51.41 (61.09)
T4	Inner polyethylene linedHDPEbags	7.95 (1.91)	15.60 (7.23)	11.78 (4.17)	16.05 (7.64)	28.88 (23.33)	22.46 (14.60)	27.96 (21.98)	46.15 (52.00)	37.05 (36.30)	50.19 (59.00)	58.06 (72.01)	54.12 (65.65)
T5	PICSbags (Perdueimproved cropstorage bag)	0.00 (0.00)	1.91 (0.11)	0.96 (0.03)	3.83 (0.45)	9.08 (2.49)	6.45 (1.26)	10.96 (3.61)	13.73 (5.63)	12.34 (4.57)	17.75 (9.30)	18.73 (10.31)	18.24 (9.80)
T6	Closely woven net bags	0.00 (0.00)	3.83 (0.45)	1.91 (0.11)	10.50 (3.32)	12.88 (4.97)	11.69 (4.11)	19.93 (11.61)	18.09 (9.65)	19.01 (10.61)	36.66 (35.65)	25.08 (17.97)	30.87 (26.33)
T7	Cloth bags	10.96 (3.61)	14.95 (6.66)	12.96 (5.03)	20.54 (12.31)	30.65 (26.00)	25.60 (18.67)	45.96 (51.67)	46.91 (53.34)	46.43 (52.49)	60.68 (76.02)	61.58 (77.35)	61.13 (76.69)
	T												

	S. Em ±	1.01	1.25	1.65	0.97	1.10	1.87	0.98	0.79	3.95	0.76	0.91	3.38
	CD at 5%	3.06	3.80	5.70	2.94	3.34	6.46	2.98	2.40	13.66	2.31	2.77	11.68
	CV%	31.70	19.44	23.63	11.72	8.22	9.57	6.25	3.83	4.91	2.87	3.46	3.18
	Y												
	S. Em ±			0.88			1.00			2.11			1.80
	CD at 5%			3.05			3.45			7.30			NS
	T x Y												
	S. Em ±			1.14			1.04			0.89			0.84
	CD at 5%			3.30			3.01			2.58			2.43

*arcsin √percentage transformation value**figure in parenthesis are retransformed value

Table No. 4: Percent pod damage (On Weight base) during storage of groundnut due to Bruchid

Sr. No.	Treatments	% pods Damage on weight base								
		After 5 month			After 6 month			After 7 month		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T1	Jute bags	18.27* (9.83)**	*27.47 (21.27)**	22.87 (15.10)	30.39 (25.59)	41.42 (43.77)	35.90 (34.38)	56.61 (69.71)	50.01 (58.70)	53.31 (64.30)
T2	HDPE bags	17.23 (8.77)	27.12 (20.78)	22.18 (14.25)	30.89 (26.35)	41.11 (43.24)	36.00 (34.55)	53.03 (63.83)	52.51 (62.96)	52.77 (63.40)

T3	Inner polyethylene lined jute bags	15.81 (7.43)	27.21 (20.91)	21.51 (13.44)	27.84 (21.81)	43.78 (47.87)	35.81 (34.23)	48.60 (56.27)	54.22 (65.81)	51.41 (61.09)
T4	Inner polyethylene lined HDPE bags	17.04 (8.59)	29.24 (23.86)	23.14 (15.44)	29.42 (24.13)	47.23 (53.88)	38.32 (38.45)	51.97 (62.05)	57.98 (71.89)	54.98 (67.07)
T5	PICS bags(Perdue improved crop storage bag)	4.73 (0.68)	9.97 (2.99)	7.35 (1.64)	12.05 (4.36)	15.21 (6.88)	13.63 (5.55)	18.52 (10.09)	18.99 (10.59)	18.76 (10.34)
T6	Closely woven net bags	11.45 (3.94)	13.96 (5.82)	12.70 (4.83)	20.68 (12.47)	18.48 (10.05)	19.58 (11.23)	36.90 (36.06)	25.69 (18.79)	31.30 (26.99)
T7	Cloth bags	21.34 (13.24)	30.64 (25.98)	25.99 (19.20)	47.45(54.27)	47.31 (54.02)	47.38 (54.15)	65.70(83.06)	61.23 (76.83)	63.46 (80.03)
	T									
	S. Em ±	1.15	1.02	1.73	1.08	0.89	3.91	1.30	1.01	3.17
	CD at 5%	3.47	3.09	5.98	3.26	2.69	13.53	3.93	3.08	10.97
	CV%	13.11	7.74	9.69	6.56	4.23	5.28	4.74	3.84	4.33
	Y									
	S. Em ±			0.92			2.09			1.69
	CD at 5%			3.20			7.23			NS
	T x Y									
	S. Em ±			1.08			0.99			1.16
	CD at 5%			3.14			2.86			3.37

*arcsin √percentage transformation value**figure in parenthesis are retransformed value

Table No.5: Percent moisture content (Wb) of pods during storage of groundnut

Sr. No.	Treatments	Moisture content %								
		After 5 month			After 6 month			After 7 month		
		2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
T1	Jute bags	6.27	6.61	6.44	6.85	7.12	6.99	7.69	8.85	8.27
T2	HDPE bags	6.41	6.66	6.54	6.80	7.00	6.90	7.41	8.00	7.71
T3	Inner polyethylene lined jute bags	6.47	6.70	6.59	6.74	6.88	6.81	7.20	7.72	7.46
T4	Inner polyethylene lined HDPE bags	6.55	6.75	6.65	6.69	6.85	6.77	7.08	7.60	7.34
T5	PICSbags (Perdue improved crop storage bag)	6.64	6.84	6.74	6.68	6.80	6.74	6.80	7.00	6.90
T6	Closely woven net bags	6.18	6.50	6.34	6.91	7.35	7.13	7.61	9.17	8.39
T7	Cloth bags	6.26	6.55	6.40	7.07	7.20	7.14	7.80	8.89	8.35
	T									
	S. Em ±	0.04	0.03	0.02	0.04	0.03	0.06	0.04	0.03	0.24
	CD at 5%	0.11	0.10	0.07	0.13	0.08	0.20	0.11	0.09	0.82
	CV%	0.99	0.82	0.91	1.05	0.64	0.87	0.88	0.65	0.76

	Y									
	S. Em ±			0.01			0.03			0.13
	CD at 5%			0.04			0.11			0.44
	T x Y									
	S. Em ±			0.03			0.03			0.03
	CD at 5%			NS			0.10			0.10

Table No.6. Percent germination of kernel of groundnut during storage

Sr. No.	Treatments	% Germination After 7 month of storage		
		2017	2018	Pooled
T1	Jute bags	72.23*(90.69)**	74.74(93.07)	73.49(91.92)
T2	HDPE bags	73.65 (92.08)	74.07(92.47)	73.86(92.27)
T3	Inner polyethylene lined jute bags	75.07 (93.36)	72.90(91.36)	73.99(92.39)
T4	Inner polyethylene linedHDPEbags	74.40 (92.77)	70.67(89.04)	72.53(90.99)
T5	PICSbags (Perdueimproved cropstorage bag)	78.72 (96.17)	77.64(95.42)	78.18(95.80)

T6	Closely woven net bags	76.70 (94.71)	75.91(94.07)	76.31(94.40)
T7	Cloth bags	69.77 (88.05)	68.66(86.76)	69.22(87.41)
	T			
	S. Em ±	1.16	1.21	0.84
	CD at 5%	3.52	3.67	2.43
	CV%	2.70	2.85	2.78
	Y			
	S. Em ±			0.45
	CD at 5%			NS
	T x Y			
	S. Em ±			1.19
	CD at 5%			NS

*arcsin √percentage transformation value**figure in parenthesis are retransformed value

Table : 7 Economics of different storage bags for storage of groundnut

No	Treatment detail	Cost of Treatment (Rs.)	Expected life of bag (Year)	Depreciation cost (Rs/year)	Annual cost for 100 kg storage (Rs)	Healthy pod obtained, kg/100 kg	Price of Healthy seed, Rs 45 /kg	Net gain over Jute bag	ICBR
1	Jute bags	Rs 60/35 kg	4	15	43	66.31	2984	----	---
2	HDPE bags	Rs 20/20 kg	2	10	50	67.00	3015	31	1:0.62
3	Inner polyethylene lined jute bags	Rs 70/35 kg	4	17.5	50	67.10	3020	36	1:0.72
4	Inner polyethylene lined HDPE bags	Rs 30/20 kg	2	15	75	63.70	2866	-118	1:-1.57
5	PICS bags	Rs100/40kg	2	50	125	95.43	4294	1310	1:10.48
6	Closely woven net bags	Rs 60/ 30kg	2	30	100	89.39	4023	1039	1:10.39
7	Cloth bags	Rs 80/ 35kg	2	40	114	47.51	2138	-846	1:-7.42

Table No.8: Total aflatoxin percentage in groundnut after seven month of storage.

Sr. No.	Treatment	Total aflatoxin percentage 2017 (LCMS QTOF method)	Total aflatoxin percentage 2018 (HPLC method)	Remark: Permissible level of aflatoxin
1	PICS bags (Perdue improved crop storage bag)	24.10 ppb	Absent	1. 4ppb in European union. 2. 20ppb in USA 3.30ppb for Agmark standards in India
2	Closely woven net bags	21.68 ppb	Absent	

Weather data during storage period

Month	Temperature			RH%		
	Maximum	Minimum	Mean	I	II	mean
1st year Expt. Duration						
December 2016	32.5	13.4	22.9	74.8	27.4	51
January 2017	29.9	11.9	20.9	72.5	29.5	51
February 2017	34.3	15.2	24.7	62.8	21.8	42
March 2017	36.7	18.7	27.7	55.5	20.4	38
April 2017	39.3	22.0	30.7	67.4	26.3	47
May 2017	40.5	24.7	32.6	77.7	33.1	55
June 2017	37.0	26.6	31.8	81.4	56.6	69
July 2017	30.9	25.4	28.1	91.1	78.9	85
2nd year Expt. Duration						
December 2017	29.1	14.8	21.9	69.1	38.1	54
January 2018	30.0	13.2	21.6	73	28	51
February 2018	33.0	16.2	24.6	62	23	43
March 2018	37.6	2.2	28.9	91	19	55

April 2018	40.3	23.7	32.0	73	20	47
May 2018	41.1	26.9	34.0	81	27	54
June 2018	37.1	28.1	32.6	80	49	65
July 2018	30.7	25.8	28.3	92	78	85

11. Financial Implications (in Lakhs)

11.1 Expenditure on

(a) Manpower: 21.00 lakhs

(b) Research/Recurring Contingencies: 0.40 lakh

(c) Non-Recurring Cost (Including cost of equipment): Nil

(d) Any Other Expenditure Incurred: Nil

11.2 Total Expenditure : 21.40 lakhs

12. Cumulative Output

i. Special attainments/innovations
j. List of Publications (one copy each to be submitted if not already submitted)
    i. Research papers
    ii. Reports/Manuals
    iii. Working and Concept Papers
    iv. Popular articles
    v. Books/Book Chapters
    vi. Extension Bulletins
k. Intellectual Property Generation
   (Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any)
l. Presentation in Workshop/Seminars/Symposia/Conferences
   (Relevant to the project in which scientists have participated)
m. Details of technology developed
   (Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)
n. Trainings/demonstrations organized
o. Training received
p. Any other relevant information

13. (a) Extent of achievement of objectives and outputs earmarked as per RPP-I

Objective wise	Activity	Envisaged output of monitorable target(s)	Output achieved	Extent of Achievement (%)
1.	Planning the experiment		100%	100%
2.	Data collection		100%	100%
3.	Statistical analysis and Report writing		100%	100%

(b) Reasons of shortfall, if any: Nil

14. Efforts made for commercialization/technology transfer

15. (a) How the output is proposed to be utilized?

(b) How it will help in knowledge creation?

16. Expected benefits and economic impact (if any)

17. Specify whether the project requires submission of RPP-IV for up scaling of research output.

18 Future line of research work/other identifiable problems

19. Details on the research data (registers and records) generated out of the project deposited with the institute for future use

20. Signature of PI, CC-PI(s), all Co-PIs

21. Signature of Head of Division

22. Observations of PME Cell based on Evaluation of Research Project after Completion

23. Signature (with comments if any along with rating of the project in the scale of 1 to 10 on the overall quality of the work) of JD (R)/ Director

Plate 3.1 Groundnut pods stored in different bags.

Project – 2

Value chain in onion

ANNEXURE - V

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)

(Refer for Guidelines ANNEXURE-XI (E))

16. Institute Project Code :

17. Project Title : Forced air curing of onion.

18. Reporting Period : 2018 – 19 (March, 2018 to December, 2018)

19. Project Duration: Date of Start - April, 2017 Likely Date of Completion – June, 2019

20. Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions/deletions

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. M. N. Dabhi Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	Planning, data collection, statistical analysis and final report Writing
2.	Dr. P. R. Davara, Assistant Research Engineeri, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	20%	Helping in analysis and data collection
3.	Er. H. R. Sojaliya, Senior Technical Assistant, AICRP on PHET,	Co-PI	20%	Helping in analysis and data collection

	Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh			

21. (a) Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1.	Design of forced air curing system	M.N.Dabhi	100%	100 %
2.	Development of forced air curing system	M.N.Dabhi P R Davara	100%	100 %
3.	Curing of onion with foliage	M.N.Dabhi H R Sojaliya	50%	100 %
4.	Curing of onion without foliage	M.N.Dabhi H R Sojaliya	-	100%
5.	Storage of cured with foliage onion	M.N.Dabhi H R Sojaliya	50%	100%
6.	Storage of cured without foliage onion	M.N.Dabhi H R Sojaliya	-	100%
7.	Statistical analysis and Report writing	M.N.Dabhi P R Davara	-	100%

(b) If shortfall/addition, reasons for the same and how to catch up with the intended activities : NA

22. Annual Progress Report (research results and achievements in bullets)

Justification :

Onion (*Allium cepa* L.) is an important commercial crop grown all over the country. It originated in Central Asia. It is highly nutritive and has very good medicinal value. India ranks second in area (10.64 lakh ha) and production (151.18 lakh T) after China and third in export (11.63 lakh MT) after Netherlands and Spain .The major onion growing states are Maharashtra, Bihar, Karnataka, Gujarat, Andhra Pradesh, Uttar Pradesh, Orissa and Madhya Pradesh (Anon., 2011). Onion is a seasonal crop and has low storability. The bulbs have to be stored for longer periods due to seasonal glut in market. A significant loss in quality and quantity of onion occurs during storage, especially in tropical countries like India. Storage is an important aspect of post

harvest management. The post harvest loss occurs due to physiological loss in weight, sprouting, rotting etc. Therefore proper storage is necessary to extend its period of availability through arresting metabolic breakdown and microbial spoilage. Curing is the most important post harvest operation to reduce the post harvest losses to a larger extent. It is a drying process intended to dry off the neck and outer scale leaves of the onion bulbs to prevent the loss of moisture and attack by microbes during storage. It removes the field heat and detachment of soil adheres to the roots. It also helps in shedding of dried roots and removal of foliage leaving 2.5-3 cm was found beneficial after curing which helps in reducing the post harvest losses. Curing may be done in sun, shade, and artificially. Curing in the field is the least expensive of all methods and allows nutrients to return from the tops to the bulb, thus enhancing quality. Yet suitable climatical conditions for this to occur in the field cannot be guaranteed (Smittle and Williamson, 1978).

Objectives:

1. To design forced air curing system for Talaja Red onion.
2. To develop forced air curing system.
3. Storage of cured onion
4. Pathological observation of cured and stored onion
5. Comparison of forced air curing system with natural curing system.
6. Cost economic of forced air curing system.

Technical programme:

(a) Design : CRD

(b) Variables

1. Onion with foliage and onion without foliage
2. Air temperature 40 ^{o}C and 45 ^{o}C (At air velocity 1.2 m/s)

(c) Measuring parameters:

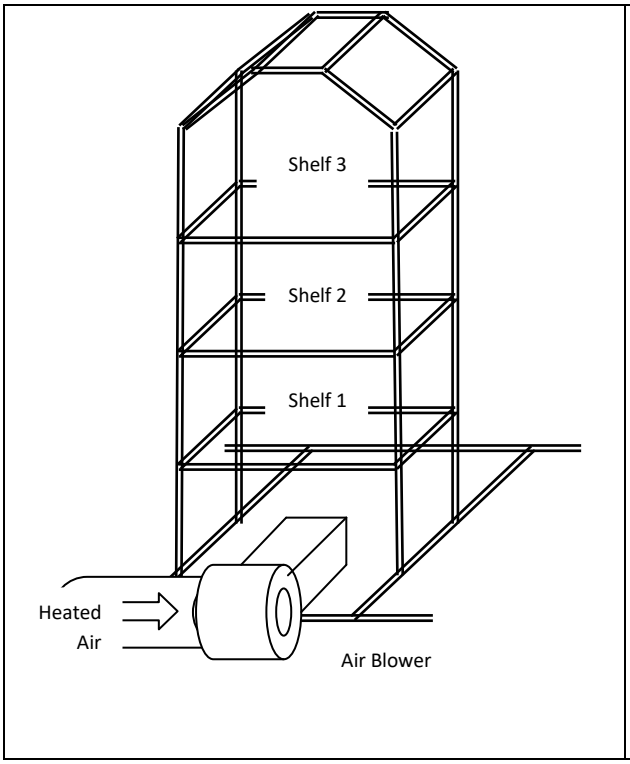
1. Moisture content of onion
2. Sprouting of onion
3. Weight loss
4. Black mold
5. Soft rot

(d) Replications: 6

(e) Sample size for each test run: Three crates of 10 kg onion in each crate

Results and discussions:

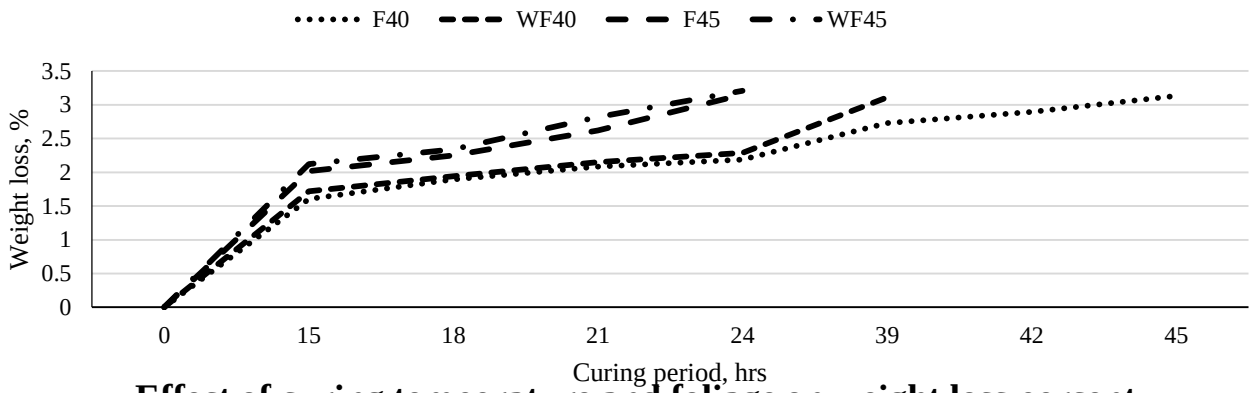
A wooden cabinet with 25 x 25 x 5 mm iron angle for curing of onion was designed and developed based on the onion to be cured with vegetable tray. Three vegetable tray can be arranged in a one cycle of curing. Heater and blower were arranged for supplying hot air to the cabinet. Air was supplied form bottom of the cabinet with plenum chamber. Stands inside the cabinet for three vegetable crates were designed and arranged for easily placing in and out to and from cabinet.



Freshly harvested kharif onion were obtained from the Farmers field from Pravinbhai Thummar, Village Vadal, Dist. Junagadh. Curing of with and without foliage onion (10 kg sample size in each vegetable crate) were carried out till the upper layer of onion bulb becomes loose. Cured without foliage onion were cut from the top to remove the foliage. Curing time and weight of onion were observed and recorded. Cured onions were stored in the onion storage structure. Storage parameters viz. moisture content, weight loss, black mold, soft rot, sprouting were observed before the storage and every month of storage period.

KHARIF ONION:

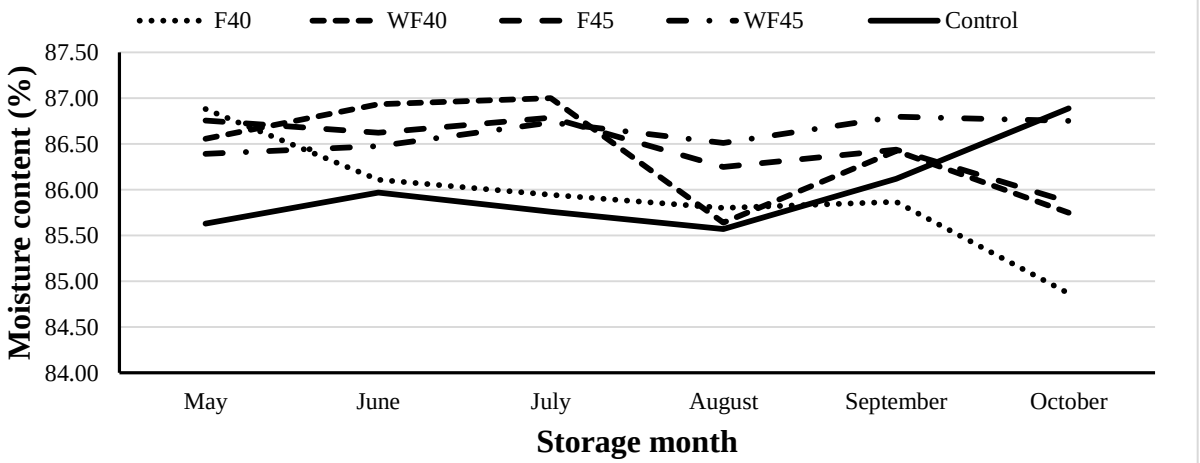
Effect of curing temperature and foliage on weight loss during curing period



Effect of curing temperature and foliage on weight loss percent during curing period for kharif onion

Curing was carried out in three vegetable crate at a time with about 10-12 kg per crate. Weight loss was recorded after 15 hrs and until the three percent weight loss as well as when the upper skin layer of onion becomes loose the curing was stopped. Curing period for Kharif onion was recorded and presented in above graph. It was observed that onion with foliage at 45 ^{o}C required less time for loosening of upper layer of onion bulb. Curing with 40 ^{o}C curing temperature with foliage required more time for curing.

Effect of curing temperature and foliage on moisture content of onion during storage:



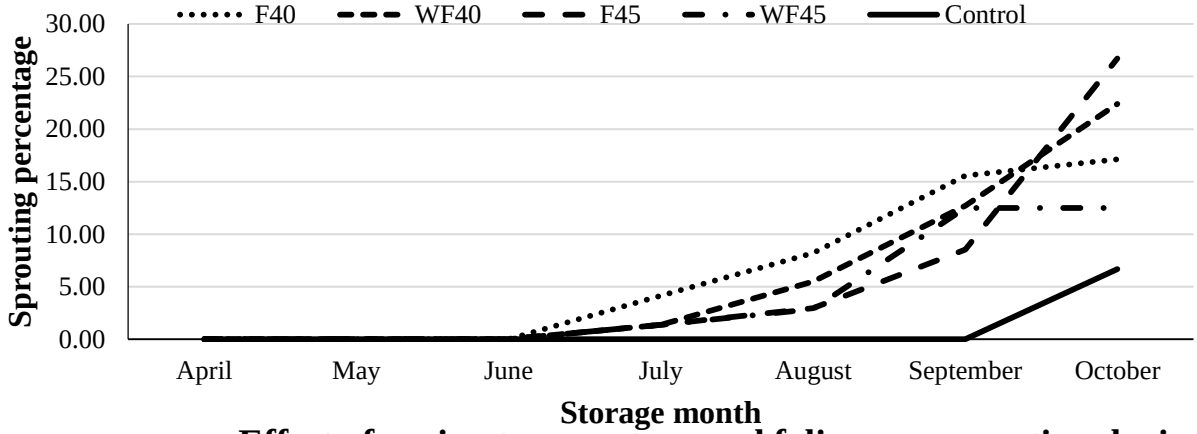
Effect of curing temperature and foliage on mositure content during storage period for kharif onion

It was observed that there was non-significant change in moisture content due to curing temperature effect first five months but it was significant after six month of storage. Similarly effect of foliage on moisture content was also found non-significant first five months and significant after six month of storage. Combined effect of curing temperature and foliage was significant after second and sixth month of storage where as it was non-significant after first, third, fourth and fifth month of storage for moisture content. At the end of six month of storage lowest moisture content was found for the curing treatment with

40 ^{o}C curing temperature and with foliage curing. Similarly highest moisture content was found for the curing treatment with 45 ^{o}C curing temperature and without foliage curing. This may be due to initial higher moisture content for this treatment. There was lesser change in the moisture content during storage period. In all the treatment there was reduction of temperature after six month of storage except curing with foliage at 45 ^{o}C and control. There was maximum increase of moisture content for control treatment. This reveals that artificial curing reduce the absorption of moisture during storage period.

Effect of curing temperature and foliage on sprouting on onion bulbs during storage:

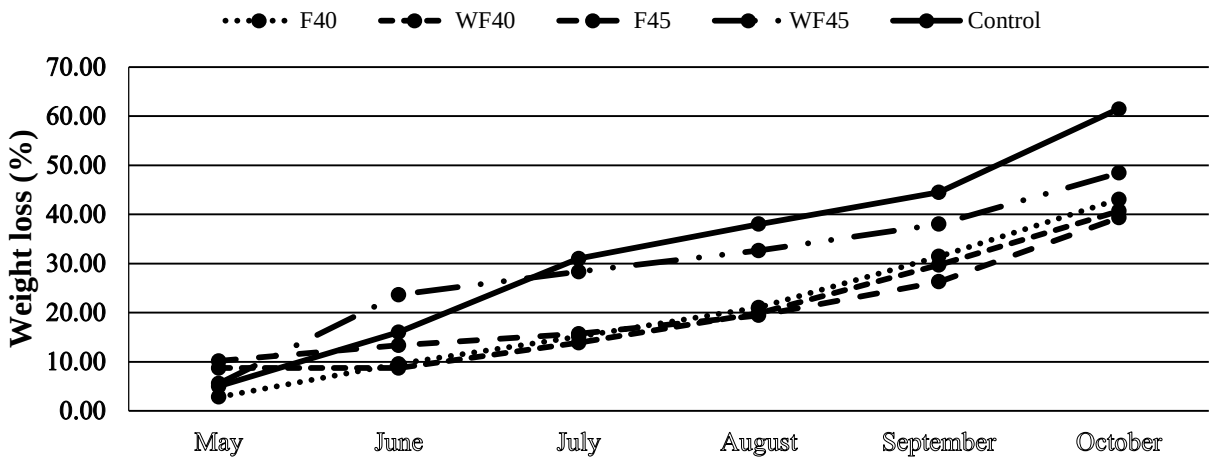
It was reported that sprouting was started in July month of storage and continued increased upto October month in the treatment with artificial curing. For the control treatment there was sprouting in the October month. For the artificial treatment sprouting was started in June month of storage and continue upto October month of storage. Maximum (26.71%) sprouting was found in treatment 45 ^{o}C curing temperature with foliage. Minimum (0.98%) sprouting was found in the control treatment. Statistically, it was observed that there was non-



Effect of curing temperature and foliage on sprouting during storage period for kharif onion

significant effect of individual curing temperature and foliage as well as interaction of curing temperature and foliage.

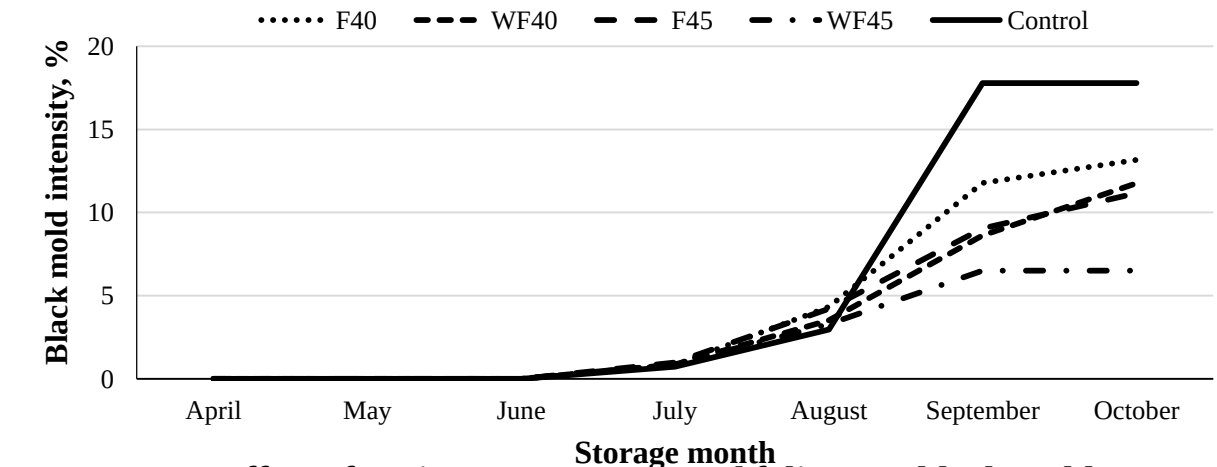
Effect of curing temperature and foliage on weight loss on onion bulbs during storage:



Effect of curing temperature and foliage on weight loss during storage period for kharif onion

It was observed that effect of curing temperature was significant only for June and July month of storage whereas effect of foliage was non-significant for all months of storage period. Interaction of curing temperature and foliage was non-significant for fifth and sixth storage months. This shows that there was variation in effect of curing temperature, foliage and interaction. After six month of storage there was no significant of any parameter. Maximum weight loss in traditional curing system (61.50%) followed by found in treatment combination of 45^{o} C curing temperature without foliage (48.43%) whereas minimum (39.30%) weight loss found in the treatment combination of 45^{o} C curing temperature with foliage after six month of storage.

Effect of curing temperature and foliage on black mold intensity on onion bulbs during storage:



Effect of curing temperature and foliage on black mold intensity during storage period for kharif onion

Pathogenic disease like black mold due to *aspergilus niger* and soft rot due to *Erwinia* were observed during storage period. It was observed that black mold intensity on onion bulb surface increases continuously during storage period after June month. There was significant effect of curing temperature on black mold intensity during storage period except July month of storage. There was significant effect of foliage on black mold intensity during July, September, and October month of storage. In the month of August, there was non-significant effect of foliage for black mold intensity during storage. Interaction of curing temperature and foliage had non-significant effect on black mold intensity for all the storage month except October month of storage. This shows that there was variation in effect of curing temperature only during June and July month and no variation in effect of foliage as well as interaction for black mold during storage. Maximum black mold intensity (17.78%) was found for the control treatment where it was minimum (6.52%) for the treatment combination of 45^{o}C curing temperature without foliage.

23. Output During Period Under Report

a. Special attainments/innovations - Nil
b. List of Publications (one copy each to be submitted with RPP-II) -
    i. Research papers :
    ii. Reports/Manuals
    iii. Working and Concept Papers
    iv. Popular articles
    v. Books/Book Chapters
    vi. Extension Bulletins
c. Intellectual Property Generation - Nil
    i. (Patents - filed/obtained; Copyrights- filed/obtained; Designs-filed/obtained; Registration details of variety/germplasm/accession if any)
d. Presentation in Workshop/Seminars/Symposia/Conferences - Nil
    i. (relevant to the project in which scientists have participated)
    ii. Research paper entitled "Effect of artificial curing on storage disease of onion" was presented in International Symposium on Engineering Technologies for Precision and Climate Smart Agriculture, at BHU, Varanasi during 28-30 January, 2019.

e. Details of technology developed – Curing chamber was developed
    i. (Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)
f. Trainings/demonstrations organized - Nil
g. Training received- Nil
h. Any other relevant information - Nil

24. Constraints experienced, if any

25. Lessons Learnt: It was learnt that forced air curing reduces the period of curing as well as reduction in pathological deceased which help to get more quantity of onion after six month of storage.

26. Evaluation

(a) Self-evaluation of the project for the period under report by the PI with ratin 8
in the scale of 1 to 10

(b) Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10
1	Dr. M. N. Dabhi	PI	8
2	Dr. P. R. Davara,	Co-PI	4
3	Er. H. R. Sojaliya,	Co-PI	8

27. Signature of PI, CC-PI(s), all Co-PIs

28. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section

29. Comments of IRC

30. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director

ANNEXURE - V

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)

(Refer for Guidelines ANNEXURE-XI (E))

1.Institute Project Code : PH/JU/2017/02

2. Project Title: Testing of ozonization against storage insect pest of wheat.

3. Reporting Period: June2017 to December 2018

4. **Project Duration**: Date of Start –June 2017 Likely Date of Completion–January 2019

5.Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions/deletions

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time spent (%)	Work components assigned to individual scientist
1.	R.D.Dhudashia Assistant Entomologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	Planning, data collection, statistical analysis and final report Writing
2.	A.M.Joshi, Assistant Moicrobiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	20%	Helping in analysis and data collection
3.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	20%	Supervision and Co-tion Coon

6. (a) **Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)**

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1.	Planning the experiment	R.D.Dhudashia M.N.Dabhi	Planning the experiment 100%	100%
2.	Data collection	R.D.Dhudashia A.M.joshi	Data collection is completed 100%	100%
3	Statistical analysis and Report writing	R.D.Dhudashia M.N.Dabhi	Statistical analysis and Report writing is under progress	under progress

(b) **If shortfall/addition, reasons for the same and how to catch up with the intended activities**

7. Annual Progress Report (research results and achievements in bullets)

Back ground information:

Wheat is an important cereal crop in India. In India, wheat occupies 30.00 million hectares with total production of 93.51 million tones. (Anonymous 2012-13a). In Gujarat, wheat occupies 1.05 million hectares with total production of 3.14 million tones and productivity of 2990 kg/ha (Anonymous 2012-13b).Wheat when stored is often attacked by number of pests, viz. Lesser grain borer, Khapra beetle, Rust red flour beetle, etc. Fumigation is the best technique to completely remove the pests from the grains. Many fumigants have been found effective against storage pests, but are hazardous, due to their residual effect in the grains. This adverse effect of chemical fumigants need diversified efforts for evolving more convenient, safer and alternative methods to minimize the losses on wheat.

Ozone in its gaseous form has been shown to have potential to kill insect pests in commodities (Mason et al., 1999; Kells et al., 2001). High mortality was achieved for adults of the maize weevil, Sitophiluszeamais Motschulsky, and the larvae of the Indian meal moth, Plodiainterpunctella Hubner when exposed to low ozone concentrations ranging from 5 to 45 ppm (Kells et al., 2001).Ozone toxicity during ontogeny of two species of flour beetles,*T.confusum and T.casteneum* was tested by Erdman,H E.(1980).

Ozone is a highly reactive form of oxygen where three molecules are bonded together. Interest in ozone applications for agriculture and food processing has increased in recent years. In 2001, ozone was declared a GRAS (generally recognized as safe) substance by the FDA, USA.Ozone is a safe, powerful disinfectant as well as the

strongest commercially available oxidant; it can be used to control biological growth of unwanted organisms in products and equipment used in the food processing industries. Ozone is particularly suited to the food industry because of its ability to disinfect microorganisms & pests without adding chemical.

Objectives:

1. To evaluate the effect of ozonization treatments & packaging materials against storage insect pest of wheat.
2. To evaluate the effect of ozone treatments & packaging materials on germination of wheat.

Experimental detail:

(a) Design: FCRD

(b) Factor (i) : O1- Ozone treatment @400mg/hr. for 1 minute
O2- Ozone treatment @400mg/hr. for 2 minute
O3- Ozone treatment @400mg/hr. for 3 minute
O4- Mixed with dried neem leaves @20gm/kg wheat

Factor (ii) : B1- Storage in PICS bag
B2- Storage in Aluminium foil laminated bag
B3- Storage in Polyethylene (700 gauge) bag

(b) Treatments: 12

1.	O1B1	Ozone treatment @400mg/hr. for 1 minute and storage in PICS bag
2.	O2B1	Ozone treatment @400mg/hr. for 2 minute and storage in PICS bag
3.	O3B1	Ozone treatment @400mg/hr. for 3 minute and storage in PICS bag
4	O4B1	Mixed with dried neem leaves Mixed @20gm/kg wheat and storage in PICS bag
5.	O1B2	Ozone treatment @400mg/hr. for 1 minute and storage in Aluminium foil laminated bag
6.	O2B2	Ozone treatment @400mg/hr. for 2 minute and storage in Aluminium foil laminated bag
7.	O3B2	Ozone treatment @400mg/hr. for 3 minute and storage in Aluminium foil laminated bag
8.	O4B2	Mixed with dried neem leaves @20gm/kg wheat and storage in Aluminium foil laminated bag
9.	O1B3	Ozone treatment @400mg/hr. for 1 minute and storage in Polyethylene (700 gauge) bag
10.	O2B3	Ozone treatment @400mg/hr. for 2 minute and storage in Polyethylene (700 gauge) bag
11.	O3B3	Ozone treatment @400mg/hr. for 3 minute and storage in Polyethylene (700 gauge) bag
12	O4B3	Mixed with dried neem leaves @20gm/kg wheat and storage in Polyethylene (700 gauge) bag

(c) Replication : 3

(d) Observation to be recorded:

(A) Entomological Parameters:

i. Pest population

ii. Percent grain damage

(B) Physical parameters

i. Germination percentage

ii. Moisture content percentage

Methodology:

Good quality wheat harvested and prepared in new season was procured from market.Junagadh. 1 kg grains was stored in different bags after treatment of ozonization of wheat and kept at room temperature in laboratory. Initial observation of moisture content, germination and insect infestation were recorded at the time of storage. Monthly observations were recorded on entomological and physical parameters during storage.

Initial observation:

Germination - 98.00%,

Moisture - 8.20%,

Insect damage and live insect: Nil

Results of project:

(i) Pest population:

(a) Pest population build up of Red rust flour beetle:

Table No.1: Pest population build up of Red rust flour beetle during storage of wheat

Treatments	Av.No.of adult/200gmsample				
	After 4 month	After 5 month	After 6 month	After 7 month	After 8 month
O1	1.03(0.56)	1.09(0.69)	1.12(0.75)	1.14(0.80)	1.17(0.87)
O2	0.99(0.48)	1.06(0.62)	1.15(0.82)	1.15(0.82)	1.21(0.96)
O3	0.96(0.42)	1.03(0.56)	1.09(0.69)	1.18(0.89)	1.20(0.94)
O4	0.82(0.17)	0.92(0.35)	1.03(0.56)	1.09(0.69)	1.12(0.75)
S. Em ±	0.05	0.04	0.04	0.05	0.07
CD at 5%	0.14	0.12	NS	NS	NS
P1	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
P2	1.49(1.72)	1.66(2.26)	1.88(3.03)	2.00(3.50)	2.10(3.91)
P3	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
S. Em ±	0.043	0.03	0.03	0.04	0.06

CD at 5%	0.12	0.10	0.09	0.11	0.17
O1P1	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O2P1	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O3P1	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O4P1	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O1P2	1.68(2.31)	1.86(2.95)	1.95(3.32)	2.03(3.62)	2.08(3.84)
O2P2	1.56(1.93)	1.77(2.65)	2.04(3.65)	2.04(3.65)	2.20(4.32)
O3P2	1.46(1.64)	1.68(2.31)	1.86(2.95)	2.11(3.96)	2.19(4.28)
O4P2	1.05(0.61)	1.34(1.31)	1.68(2.31)	1.86(2.95)	1.93(3.23)
O1P3	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O2P3	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O3P3	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
O4P3	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
S. Em ±	0.08	0.07	0.06	0.08	0.11
CD at 5%	0.25	0.20	NS	NS	NS
CV%	15.61	11.65	9.93	12.01	17.00

* √x+0.5 transformation value; **figure in parenthesis are retransformed value

The results showed in Table No. 1 indicated that the individual effect of ozone treatment was found significant after four and five month of storage of wheat and non-significant after six, seven and eight month of storage. The minimum pest population was found in neem leave treatment as compared to ozone treatments after four and five month of storage. The effect of storage bag on insect infestation was found significant after four, five, six, seven and eight month of storage of wheat. The Pest population was only recorded in aluminum foil laminated bag up to eight month of storage. The interaction effect was found significant after four and five month of storage of wheat and non-significant after six, seven and eight month of storage. The pest population was not found in all PICS bags and Polyethylene bags treatments. The infestation of pest was only found in aluminum foil laminated bag treatments and remains low in neem leave treatment as compared to ozone treatment.

(b): Pest population builds up of rice moth:

Table No.2: Pest population builds up of rice moth during storage of wheat

Treatments	Av.No. larva/ bag (1.0kgwheat)							
	After 1 month	After 2 month	After 3 month	After 4 month	After 5 month	After 6 month	After 7 month	After 8 month
O1P1	0	0	0	0	0	0	0	0
O2P1	0	0	0	0	0	0	0	0
O3P1	0	0	0	0	0	0	0	0
O4P1	0	0	0	0	0	0	0	0
O1P2	0	0	0	0.67	3.00	2.33	0	0
O2P2	0	0	0	1.00	2.67	2.00	0	0
O3P2	0	0	0	0.33	3.00	2.33	0	0
O4P2	0	0	0	0.67	2.33	1.33	0	0
O1P3	0	0	0	0	0	0	0	0
O2P3	0	0	0	0	0	0	0	0
O3P3	0	0	0	0	0	0	0	0
O4P3	0	0	0	0	0	0	0	0

The results showed in Table No.2.indicated that the Pest population of rice moth was found nil in most of treatments bags. However, it was observed that the infestation of pest was only found in aluminum foil laminated bag treatments after four, five and six month of storage.

(ii) Percent grain damage due to red rust flour beetle:

Table No.3 : Percent grain damage due to red rust flour beetle during storage of wheat

Treatments	Av.No. of grain damage							
	After 1 month	After 2 month	After 3 month	After 4 month	After 5 month	After 6 month	After 7 month	After 8 month
O1P1	0	0	0	0	0	0	0	0
O2P1	0	0	0	0	0	0	0	0
O3P1	0	0	0	0	0	0	0	0

O4P1	0	0	0	0	0	0	0	0
O1P2	0	0	0	1.00	2.67	3.00	4.00	6.00
O2P2	0	0	0	1.00	2.33	2.67	4.67	5.33
O3P2	0	0	0	0.67	2.00	3.33	4.33	5.67
O4P2	0	0	0	0.00	1.33	2.00	3.00	4.67
O1P3	0	0	0	0	0	0	0	0
O2P3	0	0	0	0	0	0	0	0
O3P3	0	0	0	0	0	0	0	0
O4P3	0	0	0	0	0	0	0	0

The results in Table No.3 indicated that the damage of wheat grain was found only in aluminum foil laminated bag after four month of storage and increased up to eight month of storage. The wheat grain damage was not found in all PICS bags and Polyethylene bags treatments. It means bag treatment effect was found against the damage of wheat during storage.

(iii) Percent moisture content:

Table No.4: Percent moisture content of wheat during storage

Treatments	Percent moisture content of wheat							
	After 1 month	After 2 month	After 3 month	After 4 month	After 5 month	After 6 month	After 7 month	After 8 month
O1	9.07	9.31	10.44	11.54	12.02	10.67	9.79	9.59
O2	9.08	9.38	10.49	11.53	11.99	10.63	9.80	9.61
O3	9.04	9.28	10.42	11.50	12.00	10.63	9.79	9.59
O4	9.03	9.27	10.43	11.50	12.01	10.67	9.78	9.64
S. Em ±	0.03	0.06	0.04	0.06	0.05	0.03	0.07	0.03
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
P1	8.45	8.86	9.54	10.42	10.67	8.82	8.72	8.65

P2	9.77	10.02	11.87	13.56	14.59	13.02	11.02	10.65
P3	8.95	9.05	9.93	10.58	10.75	10.12	9.62	9.52
S. Em ±	0.02	0.05	0.04	0.05	0.04	0.03	0.06	0.03
CD at 5%	0.07	0.14	0.11	0.14	0.12	0.08	0.18	0.08
O1P1	8.40	8.90	9.47	10.47	10.73	8.77	8.70	8.63
O2P1	8.50	8.93	9.57	10.43	10.60	8.83	8.73	8.67
O3P1	8.47	8.83	9.63	10.37	10.70	8.80	8.70	8.60
O4P1	8.43	8.77	9.50	10.40	10.67	8.87	8.77	8.70
O1P2	9.80	9.97	11.87	13.60	14.60	13.07	11.07	10.60
O2P2	9.77	10.10	11.93	13.63	14.67	13.00	11.00	10.70
O3P2	9.73	9.97	11.80	13.53	14.53	12.97	11.03	10.63
O4P2	9.77	10.03	11.87	13.47	14.57	13.03	10.97	10.67
O1P3	9.00	9.07	10.00	10.57	10.73	10.17	9.60	9.53
O2P3	8.97	9.10	9.97	10.53	10.70	10.07	9.67	9.47
O3P3	8.93	9.03	9.83	10.60	10.77	10.13	9.63	9.53
O4P3	8.90	9.00	9.93	10.63	10.80	10.10	9.60	9.57
S. Em ±	0.04	0.10	0.07	0.10	0.08	0.05	0.12	0.06
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS
CV%	0.86	1.85	1.20	1.48	1.19	0.90	2.21	1.03

The results showed in Table No.4 indicated that the individual effect of ozone treatment on moisture content was found non-significant after one to eight month of storage of wheat. The individual effect of storage bag on moisture content was found significant after one to eight month of storage of wheat. The minimum moisture content was found in PICS bag up to eight month of storage and maximum moisture content was found in aluminum foil laminated bag up to eight month of storage. The interaction effect was found non-significant after one to eight month of storage.

(iv) Percent Germination:

Table No 5: Percent Germination of wheat during storage

Treatments	% Germination	
	After 1 month	After 8 month
O1	79.10*(96.42)**	75.27(93.53)
O2	80.13(97.06)	74.66(93.00)
O3	80.21(97.11)	75.47(93.71)
O4	79.91(96.93)	76.65(94.67)
S. Em ±	1.47	0.99
CD at 5%	NS	NS
P1	79.49(96.67)	76.48(94.53)
P2	80.91(97.50)	72.92(91.37)
P3	79.11(96.43)	77.15(95.05)
S. Em ±	1.28	0.86
CD at 5%	NS	2.50
O1P1	77.58(95.78)	76.37(94.45)
O2P1	79.10(96.43)	75.10(93.39)
O3P1	79.85(96.90)	77.08(95.00)
O4P1	81.43(97.78)	77.36(95.21)
O1P2	81.87(98.00)	71.66(90.09)
O2P2	80.73(97.41)	72.50(90.96)
O3P2	82.31(98.21)	73.26(91.70)
O4P2	78.72(96.17)	74.25(92.63)
O1P3	77.84(95.56)	77.79(95.53)
O2P3	80.55(97.30)	76.37(94.45)
O3P3	78.46(96.00)	76.09(94.22)

O4P3	79.60(96.74)	78.35(95.92)
S. Em ±	2.55	1.71
CD at 5%	NS	NS
CV%	5.54	3.93

*arcsin √percentage transformation value**figure in parenthesis are retransformed value

The results showed in Table No.5 indicated that the individual effect of ozone treatment on germination was found non-significant after one and eight month of storage of wheat. The effect of storage bag on germination was found non- significant after one month and significant after eight month of storage of wheat. Germination was found lower in aluminum foil laminated bag after eight month of storage. The interaction effect was also found non-significant after one and eight month of storage. The germination was slightly decreased after eight month of storage, which may be due to pest infestation and storage period.

Conclusion: Looking to the above data, the pest population, grain damage, moisture content and germination, the treatment of PICS bag and polyethylene bag was found effective against insect-pest of wheat up to eight month of storage. Moisture content was found significant in different bag. Germination percent was found non- significant it means no adverse effect of ozone treatment on germination.

8. Output During Period Under Report

q. Special attainments/innovations
r. List of Publications (one copy each to be submitted with RPP-II)
   i. Research papers
   ii. Reports/Manuals
   iii. Working and Concept Papers
   iv. Popular articles
   v. Books/Book Chapters
   vi. Extension Bulletins
s. Intellectual Property Generation
   (Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any)
t. Presentation in Workshop/Seminars/Symposia/Conferences
   (relevant to the project in which scientists have participated)
u. Details of technology developed
   (Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)
v. Trainings/demonstrations organized
w. Training received
x. Any other relevant information

9. **Constraints experienced, if any**

10. **Lessons Learnt**

11. **Evaluation**

(a) Self evaluation of the project for the period under report by the PI with ratin 9 in the scale of 1 to 10

(b) Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10
1	Prof. R.D. Dhudashia	PI	9
2	Prof. A.M. Joshi	Co PI	7
3	Dr. M. N. Dabhi	Co PI	9

12. **Signature of PI, CC-PI(s), all Co-PIs**

13.Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section

14. **Comments of IRC**

15. **Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director**

Plate 4.1 Ozonization and packing of wheat grain in different packing materials

ANNEXURE - V

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)

(Refer for Guidelines ANNEXURE-XI (E))

31. Institute Project Code :

32. Project Title : Design and development of grain treater for enzymatic pre-treatment to pigeon pea grains.

33. Reporting Period : 01-03-2018 to 30-06-2018

34. Project Duration: Date of Start – 01-03-2018 Likely Date of Completion – 31-03-2020

35. Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions/deletions

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	75%	1. Designing of grain treater 2. Development and fabrication of grain treater 3. Laboratory experiments 4. Modifications in the grain treater 5. Data collection and its analysis 6. Report writing
2.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	25%	To assist the PI in all above aspects

36. (a) Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1.	1. Review collection	Dr. P. R. Davara	100%	100%

	2. Designing of grain treater	Dr. P. R. Davara Dr. M. N. Dabhi	100%	100%
	3. Fabrication of drum	Dr. P. R. Davara Dr. M. N. Dabhi	100%	100%
	4. Fabrication of gate for loading and unloading	Dr. P. R. Davara Dr. M. N. Dabhi	100%	100%
	5. Fabrication of stand for grain treater	Dr. P. R. Davara Dr. M. N. Dabhi	100%	100%

(b) If shortfall/addition, reasons for the same and how to catch up with the intended activities

37. Annual Progress Report (research results and achievements in bullets)

(a) Objectives

1. To design and develop the grain treater for enzymatic pre-treatment to pigeon pea grains.
2. To evaluate the performance of developed grain treater.
3. To study the effect of different machine parameters on enzyme incubation efficacy.
4. To optimize the machine parameters for maximizing enzyme incubation efficacy on pigeon pea grains.
5. To estimate the cost of developed machine.

Justification :

Pigeon pea (*Cajanus cajan* L.) is one of the important pulse crops of India contributing 20.87 % to the total production of all pulses. India accounts for 90 % of the total world production of pigeon pea (Goyal *et al*., 2008). It is mostly consumed after dehulling in the form of dhal (decorticated split cotyledon). Pigeon pea is mainly consumed as dhal because it takes less time to cook and has acceptable appearance, texture, palatability, digestibility, and overall nutritional quality. The pigeon pea grain is considered as most difficult for dehulling as compared to other pulses owing to its seed coat which is more firmly attached with the cotyledons through a layer of gum and mucilage (Rout *et al.*, 2007). Due to the presence of gummy layer and hard seed coat, it is difficult to dehull.

Pre-milling treatments are generally employed to loosen the seed coat to remove husk without losing any edible portion. There are many milling methods like wet milling, dry milling, CFTRI method, Pantnagar process, CIAE method and IIPR

method developed for pigeon pea milling. There are various pre milling treatments, with respect to different milling methods, carried out before dehulling for loosening of seed coat of pigeon pea grain. All these mentioned treatments are time consuming, require almost 4 to 7 days for the complete milling of pigeon pea. But, all these pre-treatments do not permit easy removal of seed coat during the subsequent processing operation of pigeon pea milling. Moreover, these pre-treatments lead to higher processing cost, longer processing time and labour consuming for pigeon pea milling (Patel *et al.,* 2001). Enzymatic pre-treatment to pigeon pea can significantly reduce the processing time and increase the husk removal (Deshpande *et al*., 2007; Sreerama *et al.*, 2009). The enzymatic process as reported by Sangani *et al.,* (2014) involves incubation of enzyme (xylanse:pectinase:cellulase – 2:1:1) treated grains at 48.5 °C temperature for 8.69 h followed by drying and dehulling. This process resulted the increase in dehulling efficiency of enzyme treated pigeon pea grain as compared to oil treated grains. Continuous mixing of grains at uniform temperature till the end of process is the basic requirement for better efficacy of incubation. Further, incubation time and temperatures varies with variety of pigeon pea (Anon., 2017). No any machine or equipment with such facilities is available to give the enzymatic pre-treatment to the pigeon pea. Therefore, the research work has undertaken to develop the grain treater for enzymatic pre-treatment to pigeon pea grains on large scale.

Status (review) :

Saxena *et al.* (1993) used food grade mixed activity enzymes (i.e. xylanase and cellulase) as husk loosening agent. He reported a maximum hulling efficiency of 88.93 % at an enzyme concentration of 0.08 g protein per 260 g pigeon pea grain. Grains were treated with the enzyme and allowed to incubate. During this period of incubation, enzymatic hydrolysis took place which brought about the biodegradation of complex molecules of the grain. The complex gums were degraded which resulted in easy dehusking. It established that a lesser force was required to bring about the dehusking of enzyme treated grain. The action of enzyme also disturbed the microstructure of the grain affecting its strength. They further reported an increase in the protein digestibility and 37.03 % reduction in cooking time. Further, this dhal was reported to cause less gastritis due to fermentation which broke down the polysaccharides responsible for causing gastritis in many people.

Zambre (1994) reported a decrease in gum content after enzyme treatment. The protein digestibility of the treated dhal was more than that of untreated dhal. He also reported that enzyme treatment caused grain to split at a lesser force and deformation. This was due to change in microstructure which affected the strength of the grain.

Deshpande (2003) treated 60 kg pigeon pea grains with 4 % soy oil and 4 % CIRCOT enzyme. The samples treated with soy oil and enzymes were mixed thoroughly to achieve uniform application of enzyme to the grains. The treated grains were than pitted. These samples were then soaked in water for varying duration, i.e., 45, 60, 75 and 90 minutes followed by drying to 10 % moisture content. The results indicated the dhal recovery in the range of 81.11 to 84.58 % for 75 minutes subsequent soaking compared to other soaking treatments.

Technical programme

Machine parts :

1. Rotating drum with internal flights
2. Atomizers for water spray
3. Heating accessories (heating elements and thermocouple)
4. Airtight discharge gate
5. Drum speed regulator

Machine features :

1. Internal mixing flights create a gentle, four-way mixing action that tumbles, folds and turns the material.
2. Openable air tight gate fitted at the surface of drum makes easy discharge of grains after treatment.
3. Hollow pipe act as a shaft as well as facilitate the fitting of atomizers and heating accessories to create and maintain the internal condition for enzyme incubation.
4. The consistent and efficient flow pattern of grains assists in creation of ideal conditions for uniform application of water and exposure to heat for achieving homogeneous treatment.
5. Speed regulator assists to adjust the speed of drum.

Experimental design : Response Surface Methodology : CCRD (2 factors)

Independent parameters :

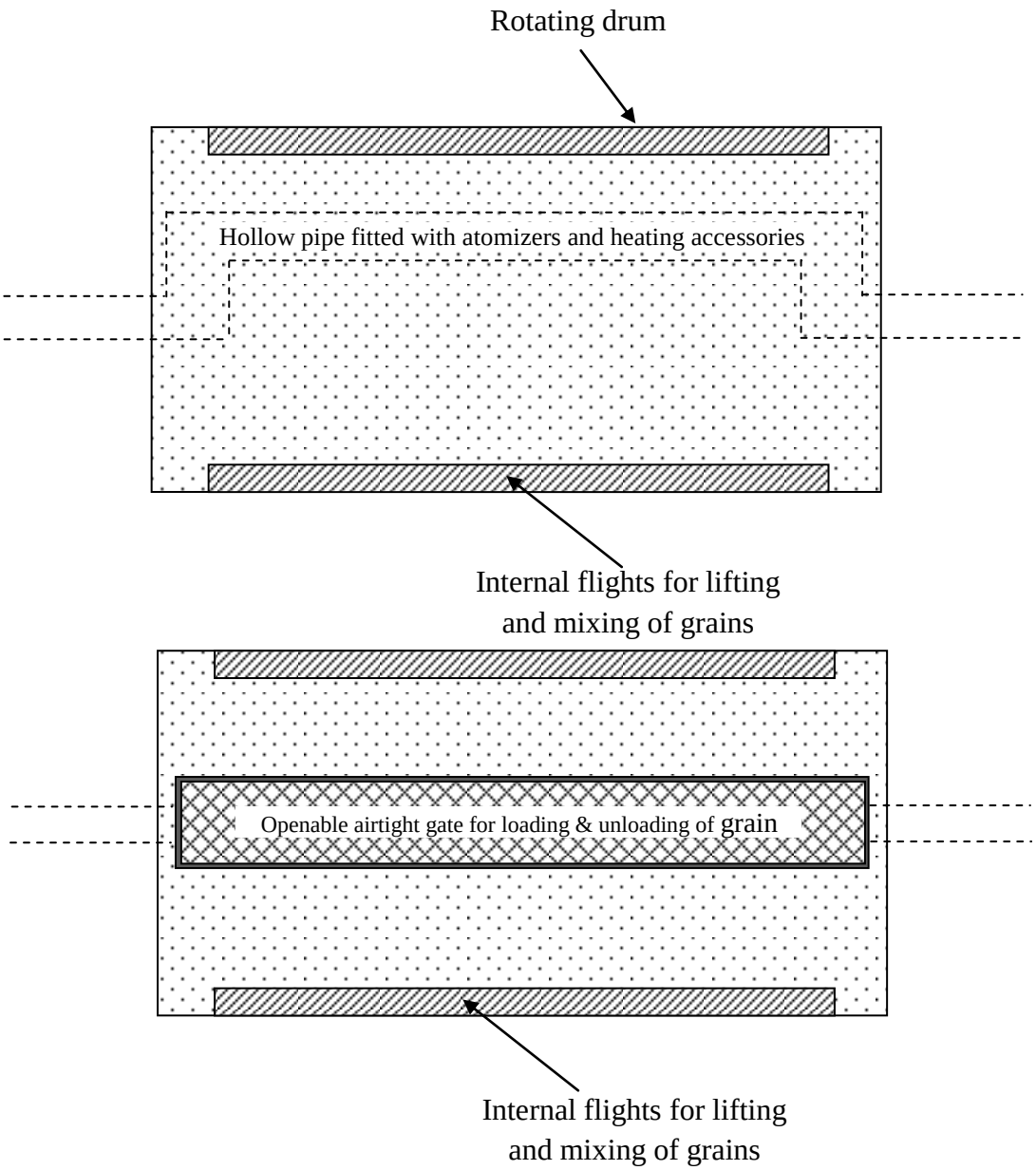
Sr. No.	Parameters	Code	Coded levels				
			-2	-1	0	+1	+2
1	Drum speed (rpm)	X_1	5	10	15	20	25
2	Drum occupied volume (%)	X_2	30	35	40	45	50

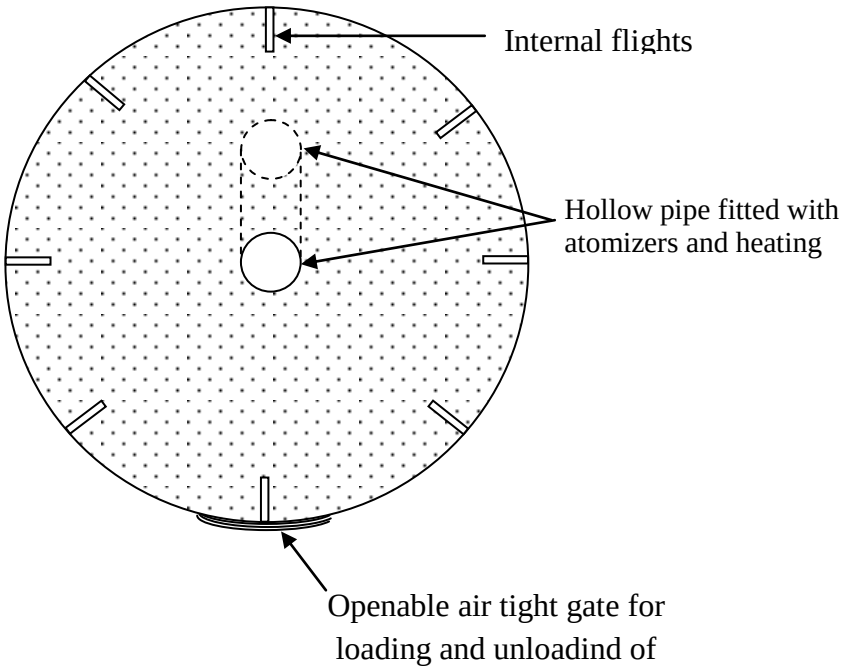
Treatment combinations :

Treatment No.	Coded variables		Uncoded variables	
	X_1	X_2	Drum speed (rpm)	Drum occupied volume (%)
1	-1	-1	10	35
2	1	-1	20	35
3	-1	1	10	45
4	1	1	20	45
5	-2	0	5	40
6	2	0	25	40
7	0	-2	15	30
8	0	2	15	50
9	0	0	15	40
10	0	0	15	40
11	0	0	15	40
12	0	0	15	40
13	0	0	15	40

Dependent parameters :

1. Machine capacity (kg/batch)
2. Hulling efficiency (%)





Conceptual design of small-scale peanut roaster

Results and Discussion

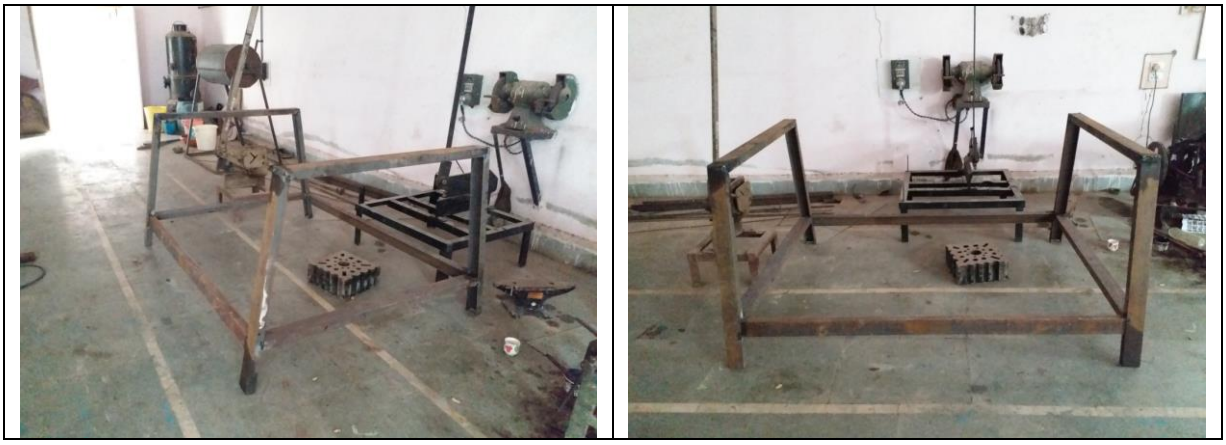
Fabrication of grain treater is under progress as shown in below given Photographs.

- **Fabrication of Drum for grain treater**

- **Fabrication of Drum for grain treater**

- **Fabrication of gate for loading and unloading**

- **Fabrication of stand for grain treater**



- **Work to be done**

1. Fabrication of heater assembly
2. Fabrication of sprayer assembly for enzyme solution spray
3. Laboratory experiments for setting up of machine parameters
4. Performance evaluation of machine
5. Cost evaluation of machine
6. Cost economics of the process
7. Report writing

References :

1. Anonymous (2017). Enzymatic pre-treatment in the processing of pigeon pea. A project report submitted to Dept. of Agriculture and Cooperation, Govt. of India under National Food Security Mission by Dept. of Food Processing, College of Agril. Engg. & Technology, Junagadh Agril. University, Junagadh (Gujarat).
2. Deshpande SD (2003) Optimization of pre milling treatments to enhance recovery of dhal. Annual Report 2001-03. AICRP on Post Harvest Technology, Bhopal Center, Presented in the 24th Annual workshop, held at GBPUA & T, Pantnagar (Feb. 12-14, 2003)
3. Deshpande, S. D., Balasubramanya, R. H., Khan, S., Bhatt, D. K. (2007) Influence of pre milling treatments on dhal recovery and cooking characteristics of pigeon pea. Journal of Agricultural Engineering, 44: 53-56.
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5. Patel, N. C, Dabhi, M. N., Chandegara, V. K., Mehta, M. H. (2001) Pulse milling industry technology up gradation: Pilot scale mill approach for R & D and application. Presented in the National seminar on emerging trends in processing, handling, storage and by-product utilization of pulses and soybean, GBPUA&T, Pantnagar (Jan. 18-19, 2001).
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Better Recovery of Dhal. International Journal of Agricultural Science and Technology, 2(4):97-105.
8. Saxena RP, Verma P, Sarkar BC, More PK (1993) Enzymatic pre treatment of pigeon pea (*Cajanus cajan* L.) grain and its interaction with milling. Journal of Food Science and Technology, 30: 368-370
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38. Output During Period Under Report

y. Special attainments/innovations

z. List of Publications (one copy each to be submitted with RPP-II)

i. Research papers - Nil
ii. Reports/Manuals - Nil
iii. Working and Concept Papers - Nil
iv. Popular articles - Nil
v. Books/Book Chapters - Nil
vi. Extension Bulletins - Nil

aa. Intellectual Property Generation
(Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any)

bb. Presentation in Workshop/Seminars/Symposia/Conferences
(relevant to the project in which scientists have participated)

cc. Details of technology developed
(Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)

dd. Trainings/demonstrations organized - Nil

ee. Training received - Nil

ff. Any other relevant information – Project is under progress

39. Constraints experienced, if any
- Nil

40. Lessons Learnt
- Nil

41. Evaluation

Self evaluation of the project for the period under report by the PI with rating in the scale of 1 to 10 8

(a) Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10
1	Dr. P. R. Davara	PI	8
2	Dr. M. N. Dabhi	Co-PI	8

42. Signature of PI, CC-PI(s), all Co-PIs

43. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section

44. Comments of IRC

45. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director

ANNEXURE - V

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR MONITORING ANNUAL PROGRESS (RPP- II)

(Refer for Guidelines ANNEXURE-XI (E))

46. Institute Project Code :

47. Project Title : Development of high protein extruded product using peanut okara flour.

48. Reporting Period : 01-03-2018 to 30-06-2018

49. Project Duration: Date of Start – 01-03-2018 Likely Date of Completion – 31-03-2020

50. Project Team (Name(s) and designation of PI, CC-PI and all project Co-PIs, (with time spent for the project) if any additions/deletions

51.

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	75%	7. Preliminary trial for peanut flour based extruded products 8. Development of high protein extruded products using defatted penut flour 9. Laboratory trials for different product formulations 10. Physico-chemical and sensory analysis of the products 11. Data collection and its analysis 12. Report writing
2.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	25%	To assist the PI in all above aspects

52.(a) Activities and outputs earmarked for the year (as per activities schedule given in RPP-I)

Objective wise	Activity	Scientist responsible	% of activity envisaged to be completed as per RPP-I	% achieved as targeted
1.	1. Review collection	Dr. P. R. Davara	100%	100%
	2. Quality analysis of proposed product raw material	Dr. P. R. Davara Dr. M. N. Dabhi	100%	50%

(b) If shortfall/addition, reasons for the same and how to catch up with the intended activities

53. Annual Progress Report (research results and achievements in bullets)
- Details of progress report is given as under.

Objectives:

6. To develop a high protein extruded product using defatted peanut flour.
7. To study the effect of operational and feed parameters on different quality and sensory parameters of defatted peanut flour based extruded products.
8. To optimize the process parameters for preparation of defatted peanut flour based extruded products.

Brief Justification

The increasing amount of time spent away from home has led to an increase in snacking (Euromonitor, 2001). Consumers nowadays are becoming more and more aware of the concept of convenience and healthy foods. Owing to the changes in the life styles, economic status and health issues, foods are expected to meet many challenges in life. People are moving towards foods that not only prevent nutritional deficiency but also offer long term prevention from chronic diseases. This changing view and perception about food is highly influencing the consumption patterns. Expanded products like snacks and breakfast cereals are very popular today because of their crunchy texture, which arises from the honeycomb structure imparted to the material during extrusion (Barrett and Peleg, 1992).

Extrusion cooking is a short time, high temperature and high shear process. Typically, dry granulated starchy food material is fed into the extruder barrel where they are forced by rotating spiral screws from a small orifice. As the product leaves the die, typically at about 120 °C residual water in the starchy melt expands into steam forming a low density, crisp foam.

Extrusion is an ideal process that is used to make a wide range of snack and breakfast cereal products (Singh et al., 2007; Chaiyakul et al., 2008). The extrusion process is carried out on devices known as extruders. Products undergo starch gelatinization, so the extrudates are already precooked and do not require additional cooking. The extrusion process enables the use of raw materials with a wide range of granulation. Through a combination of process parameters and the use of a variety of recipes, it is possible to obtain an array of products with specific properties (Wójtowicz, 2008).

Peanut is the oilseed which is high in fat content, good in protein content, high in energy content, average in carbohydrate content and good in fibre content (Kathleen, 2015). Peanut flour has a relatively high protein content, bland flavor, and light tan color which allow it to be incorporated into a wide range of foods (Prinyawiwatkul et al. 1995). The use of peanut flour as a protein supplement in breakfast cereals has been extensively studied. Spadaro et al. (1971) used rice grits mixed with defatted peanut flour to make products with higher protein content and desirable cereal-like flavor. Harris et al. (1972) developed breakfast cereal flakes that compared favorably with commercial flakes by drum-rolling dough mixtures of defatted peanut, corn, and wheat flour. Extrusion of peanut flour with corn and oats produced breakfast cereals with high protein content, but these products absented peanut flavor (Ayres and Davenport, 1977). Suknark et al. (1997) recently investigated physical properties of directly expanded extrudates by blending partially defatted peanut flour with different types of starch using single-screw extruder at different conditions.

The partially defatted peanut flour produced after peanut milk preparation has not found any specific use in the food processing. This flour contains about 30% protein.

Further, the creamy white colour of this flour makes it a very suitable ingredient in the production of many value added products. The idea of production of nutrient dense ready-to-eat extruded snacks by blending of defatted peanut flour appears to be a very attractive strategy to improve the nutritional status of the snack foods. Very little information is there on use of defatted peanut flour in the extrusion process. Further, the combine effect of various operational and feed parameters in relation to product quality have not been investigated and standardized so far. Considering all these facts, the research was undertaken to develop the protein enriched extruded snack products using peanut flour and to optimize the various process parameters for best quality ready-to-eat snack food product.

Technical programme

Experimental design : Response Surface Methodology : CCRD (4 Factors)
Base material : Corn flour
Die hole : Round opening (3mm)
Feeder temp. : 60 °C
Barrel temp. : 100 °C
Feeder speed : 12 rpm
Length-to-diameter ratio : 20:1

Table 1. Independent parameters :

Sr. No.	Parameters	Code	Coded levels				
			-2	-1	0	+1	+2
1	Feed moisture content (%wb)	(X_1)	10	13	16	19	22
2	Peanut flour (%)	(X_2)	10	20	30	40	50
3	Die head temp. (°C)	(X_4)	90	105	120	135	150
4	Screw speed (rpm)	(X_5)	100	150	200	250	300

Table 2. Treatment combinations :

Treatment No.	Coded variables				Uncoded variables			
	X_1	X_2	X_3	X_4	Feed M.C. (%wb)	Peanut flour (%)	Die head temp. (°C)	Screw speed (rpm)
1	-1	-1	-1	-1	13	20	105	150
2	1	-1	-1	-1	19	20	105	150
3	-1	1	-1	-1	13	40	105	150
4	1	1	-1	-1	19	40	105	150
5	-1	-1	1	-1	13	20	135	150
6	1	-1	1	-1	19	20	135	150
7	-1	1	1	-1	13	40	135	150
8	1	1	1	-1	19	40	135	150
9	-1	-1	-1	1	13	20	105	250
10	1	-1	-1	1	19	20	105	250
11	-1	1	-1	1	13	40	105	250
12	1	1	-1	1	19	40	105	250
13	-1	-1	1	1	13	20	135	250
14	1	-1	1	1	19	20	135	250
15	-1	1	1	1	13	40	135	250
16	1	1	1	1	19	40	135	250
17	-2	0	0	0	10	30	120	200
18	2	0	0	0	22	30	120	200
19	0	-2	0	0	16	10	120	200
20	0	2	0	0	16	50	120	200
21	0	0	-2	0	16	30	90	200
22	0	0	2	0	16	30	150	200
23	0	0	0	-2	16	30	120	100
24	0	0	0	2	16	30	120	300
25	0	0	0	0	16	30	120	200

26	0	0	0	0	16	30	120	200
27	0	0	0	0	16	30	120	200
28	0	0	0	0	16	30	120	200
29	0	0	0	0	16	30	120	200
30	0	0	0	0	16	30	120	200

Raw Material

The defatted peanut flour was purchased from Nutrinity Foundation, Junagadh.

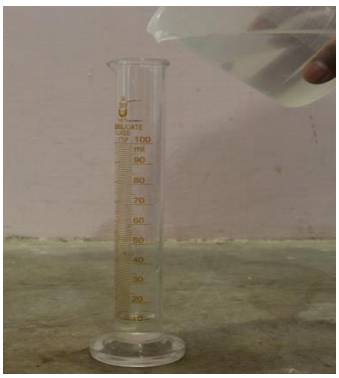
Corn flour

Defatted peanut flour

Plate 1. Corn and defatted peanut flour.

Flour preparation for extrusion cooking

Mixed flour



Water to add in the flour

Addition of water to mixed flour

Mixing and sieving of wetted flour

Plate 2. Flour preparation for the extrusion cooking.

Laboratory extruder

Extrusion trials were performed using a Co-rotating twin-screw extruder.

Plate 3. Laboratory twin-screw extruder.

Extruded product preparation

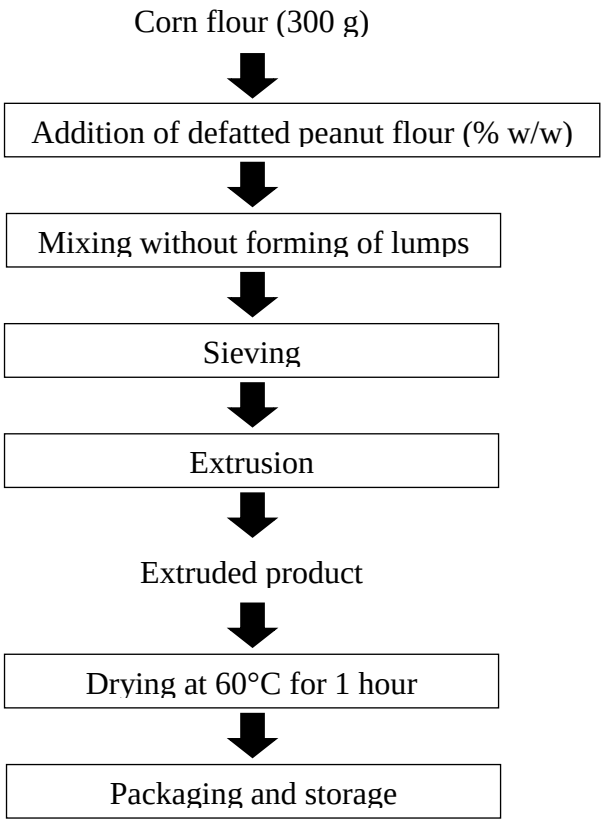


Fig. 1. Process flow chart for preparation of extruded product incorporating defatted peanut flour.

Dependent parameters :

Machine parameters :

1. Torque requirement
2. Mass flow rate

Product characteristics :

1. Moisture content
2. Protein content
3. Water holding capacity (WHC)
4. Water solubility index (WSI)
5. Water absorption index (WAI)
6. Oil absorption capacity (OAC)
7. Bulk density
8. True density
9. Rehydration ratio
10. Expansion ratio

Sensory characteristics

1. Appearance
2. Taste
3. Chewiness
4. Hardness
5. Overall acceptability

❖ **Results and Discussion**

- **Extruded product prepared by addition of defatted peanut flour**

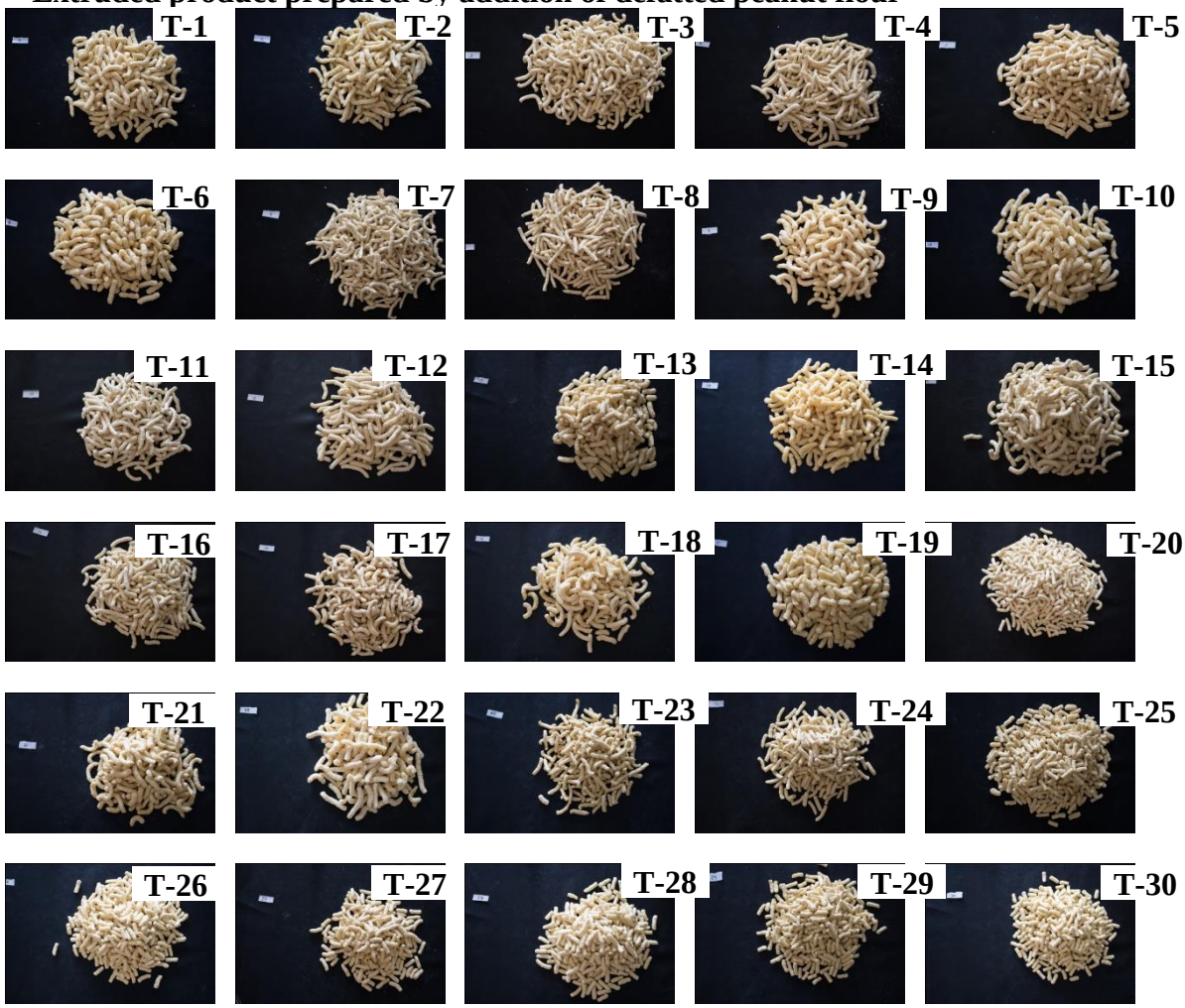


Plate 4. Extruded products prepared by addition of defatted peanut flour.

Table 3. Machine and physicochemical characteristics of extruded product prepared by addition of defatted peanut flour.

Treatment No.	Independent Variables				Response										
	Feed M.C. (X_1) (%wb)	Peanut flour (X_2) (%)	Die temp. (X_3) (°C)	Screw speed (X_4) (rpm)	Machine torque (Nm)	**Mass flow rate**	**MC (%wb)**	**Expansion ratio (mm/mm)**	**Bulk density (kg/m^3)**	**True density (kg/m^3)**	**WSI (g/g)**	**WAI (%)**	**RR**	**WHC (%)**	**Protein (%)**
1	13 (-1)	20 (-1)	105 (-1)	150 (-1)	20	111	7.56	2.80	140.40	554.18	26.69	4.30	322.56	468.50	10.32
2	19	20 (-	105	150	14	115	10.6	2.73	176.8	477.1	7.8	4.4	156.	456.	11.21

	(1)	1)	(-1)	(-1)			8		3	9	7	7	38	32	
3	13 (-1)	40 (1)	105 (-1)	150 (-1)	20	112	6.32	1.27	206.04	753.21	9.77	4.45	452.04	431.21	20.35
4	19 (1)	40 (1)	105 (-1)	150 (-1)	13	163	9.37	1.43	204.22	669.23	6.27	5.08	143.14	411.20	23.41
5	13 (-1)	20 (-1)	135 (1)	150 (-1)	19	65	5.09	2.94	112.08	598.64	19.76	4.85	511.16	396.63	10.21
6	19 (1)	20 (-1)	135 (1)	150 (-1)	12	165	8.44	3.00	110.64	511.80	14.29	5.08	544.34	344.82	12.01
7	13 (-1)	40 (1)	135 (1)	150 (-1)	18	83	4.63	2.52	173.42	552.32	18.33	4.94	489.33	359.80	19.85
8	19 (1)	40 (1)	135 (1)	150 (-1)	11	105	8.89	2.11	204.47	608.89	11.60	4.51	247.96	299.36	23.86
9	13 (-1)	20 (-1)	105 (-1)	250 (1)	18	134	5.77	3.26	71.96	495.90	24.80	4.28	458.80	268.39	11.12
10	19 (1)	20 (-1)	105 (-1)	250 (1)	10	165	10.48	2.73	86.96	575.00	9.34	4.50	372.51	301.60	10.89
11	13 (-1)	40 (1)	105 (-1)	250 (1)	18	129	4.65	1.37	112.11	756.23	11.28	4.00	161.68	254.90	18.50
12	19 (1)	40 (1)	105 (-1)	250 (1)	11	166	8.21	1.38	111.88	674.11	14.80	4.05	230.25	239.80	24.45
13	13 (-1)	20 (-1)	135 (1)	250 (1)	16	150	6.13	3.32	95.69	473.20	23.92	4.50	454.70	432.81	9.57
14	19 (1)	20 (-1)	135 (1)	250 (1)	12	182	11.4	3.17	162.64	537.12	15.14	4.91	502.47	386.53	11.32
15	13 (-1)	40 (1)	135 (1)	250 (1)	15	99	4.98	2.55	168.54	555.71	20.95	4.58	259.52	255.36	18.52
16	19 (1)	40 (1)	135 (1)	250 (1)	11	188	6.20	2.49	147.25	509.80	16.73	4.40	352.80	397.05	23.02
17	10 (-2)	30 (0)	120 (0)	200 (0)	21	86	4.37	2.22	126.19	732.10	11.42	3.81	256.32	266.40	18.47
18	22 (2)	30 (0)	120 (0)	200 (0)	18	169	8.13	2.36	89.25	656.33	8.66	4.40	203.65	277.34	16.50
19	16 (0)	10 (-2)	120 (0)	200 (0)	15	137	8.37	3.04	131.29	614.58	23.62	4.99	490.22	433.56	7.89

20	16 (0)	50 (2)	120 (0)	200 (0)	12	115	7.91	1.47	330.94	741.12	10.63	3.81	159.46	146.02	22.86
21	16 (0)	30 (0)	90 (-2)	200 (0)	14	108	8.46	1.86	176.33	734.02	9.84	3.80	139.44	224.50	17.89
22	16 (0)	30 (0)	150 (2)	200 (0)	24	143	6.83	2.76	74.55	468.55	17.39	4.54	407.44	336.44	17.67
23	16 (0)	30 (0)	120 (0)	100 (-2)	19	86	8.90	2.55	234.09	545.25	13.60	4.55	387.31	357.68	16.25
24	16 (0)	30 (0)	120 (0)	300 (2)	17	160	8.51	2.78	220.50	488.00	18.11	4.32	424.16	361.63	15.61
25	16 (0)	30 (0)	120 (0)	200 (0)	15	120	8.62	2.42	288.38	555.48	20.24	4.98	435.87	325.61	15.42
26	16 (0)	30 (0)	120 (0)	200 (0)	16	140	7.73	2.66	245.71	545.00	18.96	4.51	456.57	312.65	16.87
27	16 (0)	30 (0)	120 (0)	200 (0)	15	126	5.98	2.77	184.03	525.38	21.02	4.55	471.17	307.55	18.23
28	16 (0)	30 (0)	120 (0)	200 (0)	14	135	7.23	2.64	222.83	544.58	19.65	4.67	466.12	355.58	16.52
29	16 (0)	30 (0)	120 (0)	200 (0)	16	122	8.19	2.72	271.12	545.60	18.56	4.44	438.06	394.66	17.32
30	16 (0)	30 (0)	120 (0)	200 (0)	16	121	8.50	2.79	291.40	522.96	19.02	4.48	467.53	341.11	18.09

Response surface analysis

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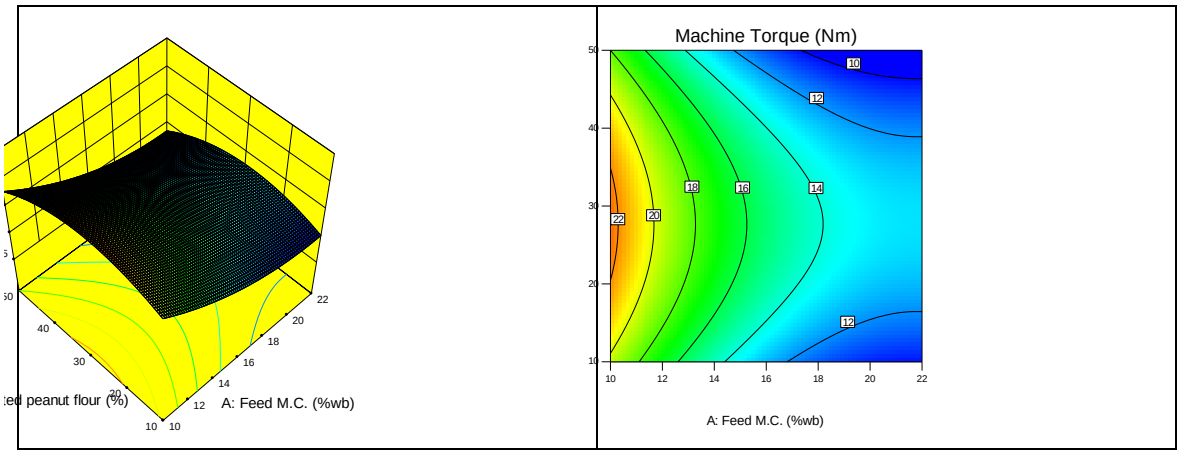

Fig. 2 Response surface and contour plot for torque as a function of feed moisture content and defatted peanut flour.

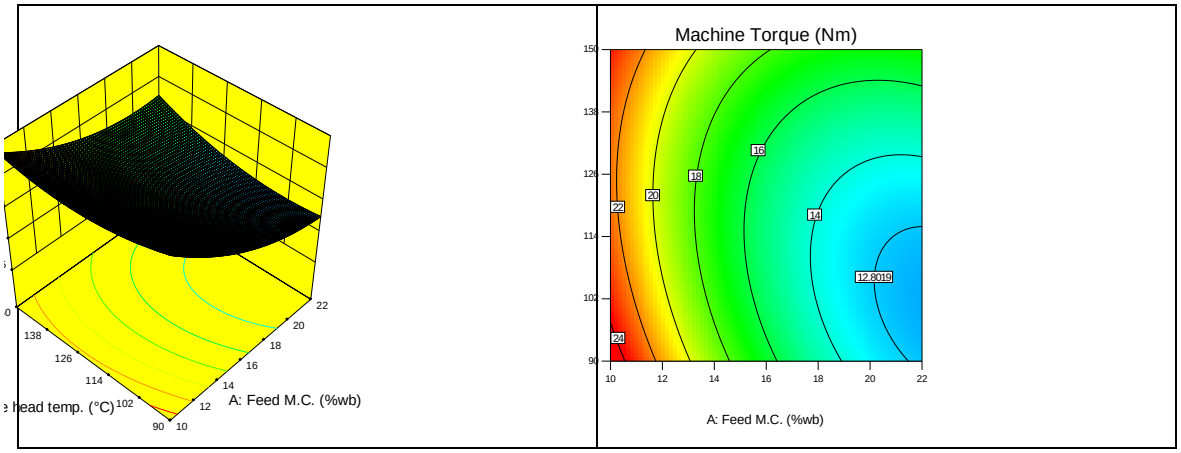

Fig. 3 Response surface and contour plot for torque as a function of feed moisture content and die head temperature.

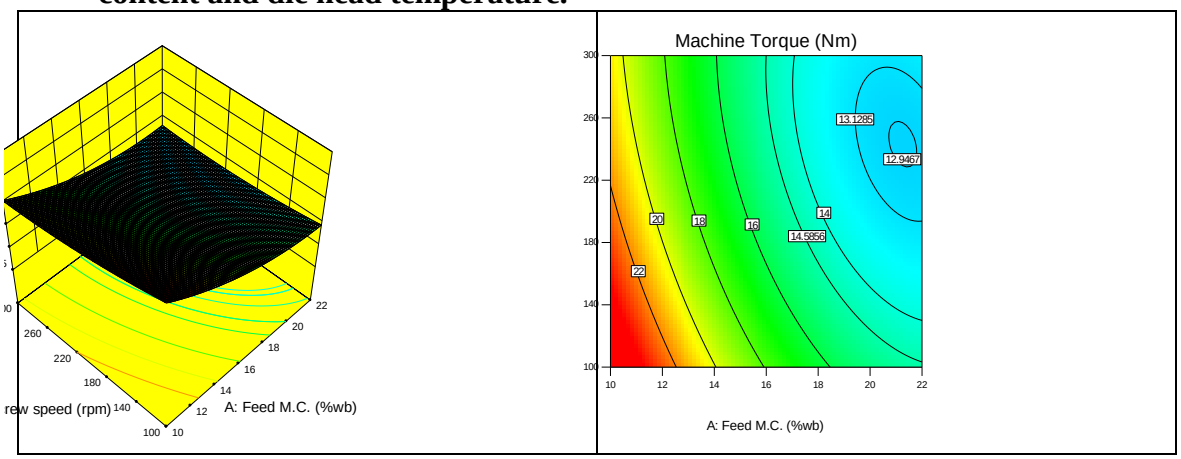

Fig. 4 Response surface and contour plot for torque as a function of screw speed and feed moisture content.

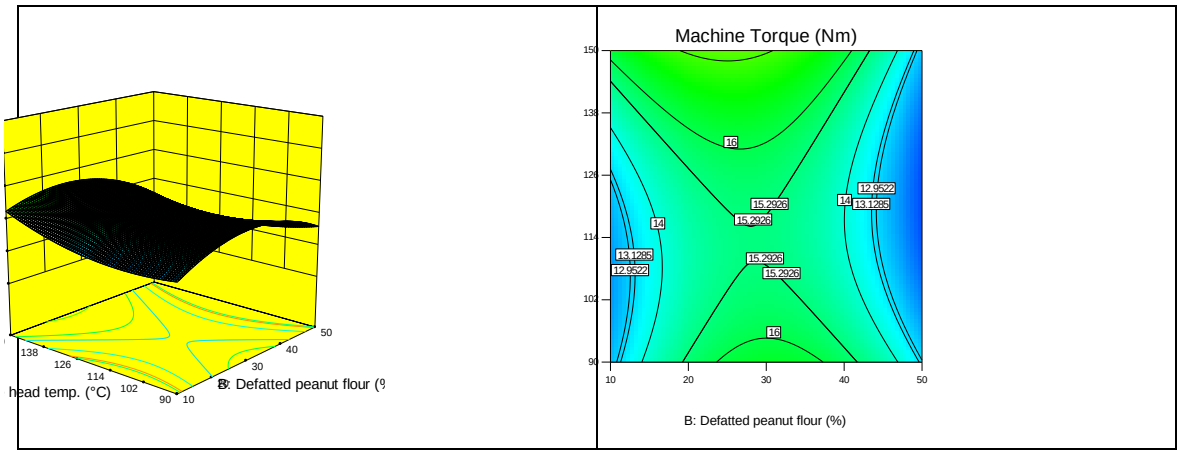

Fig. 5 Response surface and contour plot for torque as a function of defatted peanut flour and die head temperature.

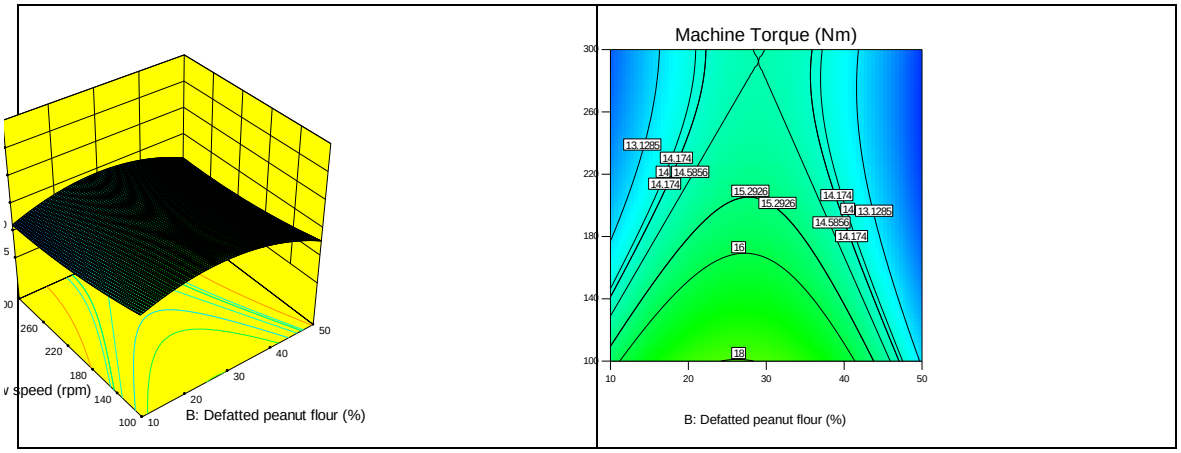

Fig. 6 Response surface and contour plot for torque as a function of defatted peanut flour and screw speed.

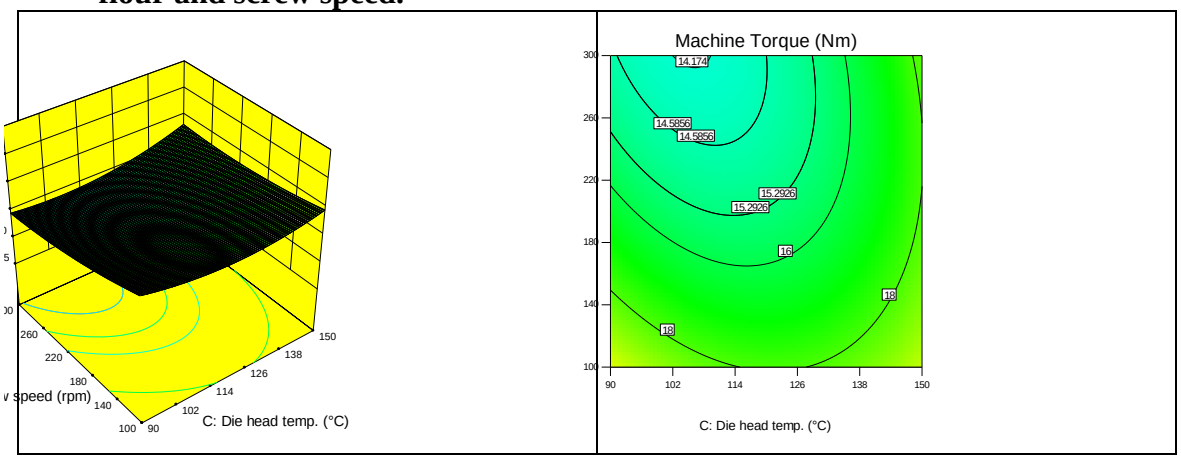

Fig. 7 Response surface and contour plot for torque as a function of die head temperature and screw speed.

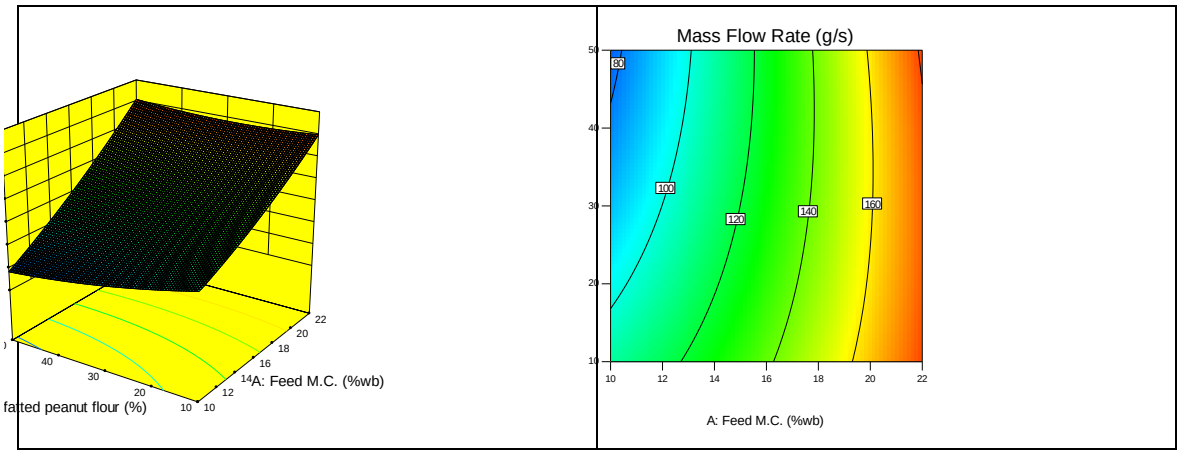

Fig. 8 Response surface and contour plot for mass flow rate as a function of feed moisture content and defatted peanut flour.

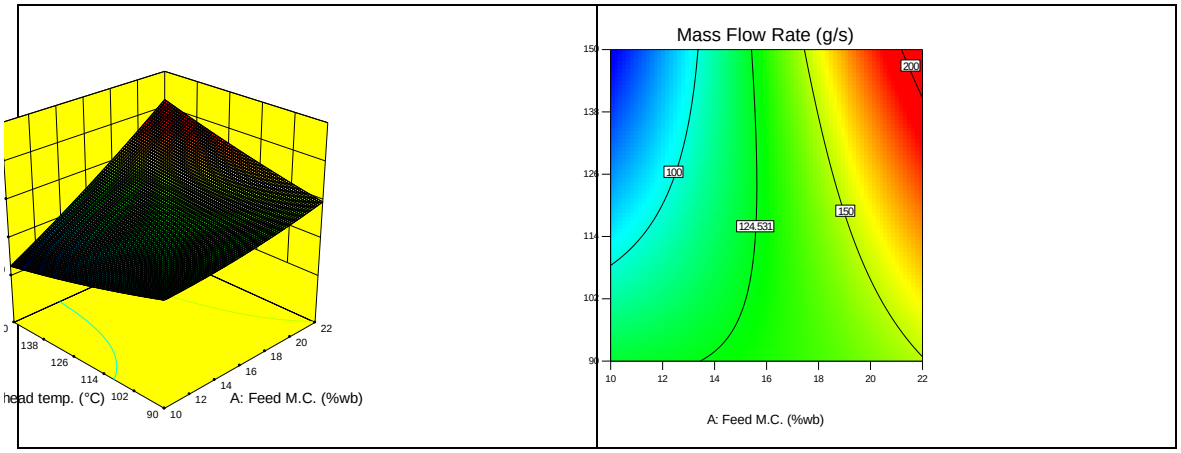

Fig. 9 Response surface and contour plot for mass flow rate as a function of feed moisture content and die head temperature.

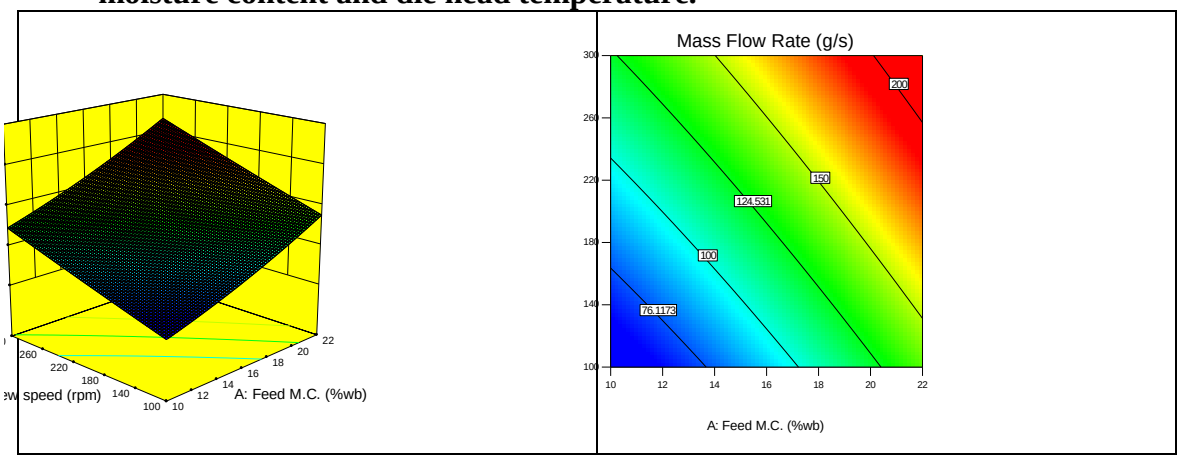

Fig. 10 Response surface and contour plot for mass flow rate as a function of screw speed and feed moisture content.

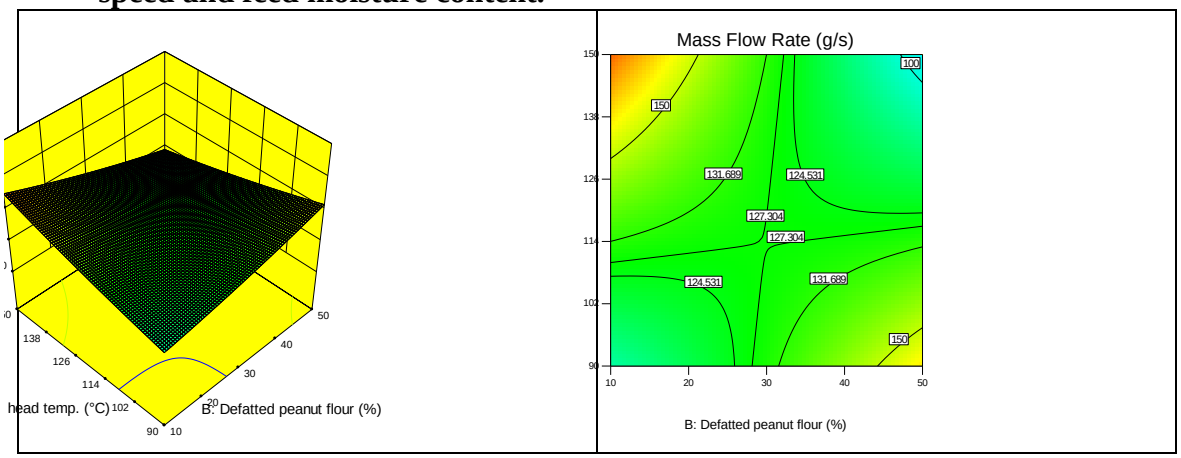

Fig. 11 Response surface and contour plot for mass flow rate as a function of defatted peanut flour and die head temperature.

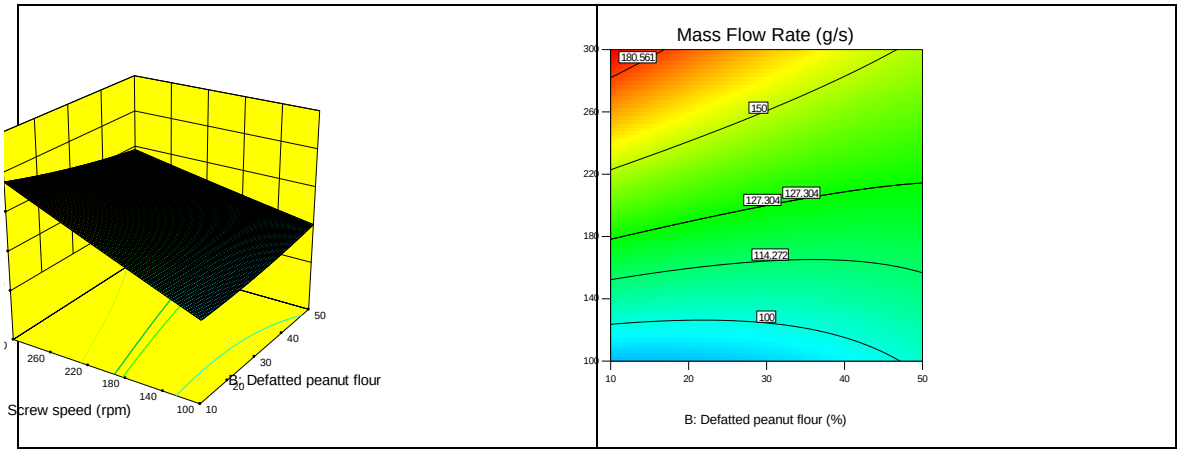

Fig. 12 Response surface and contour plot for mass flow rate as a function of defatted peanut flour and screw speed.

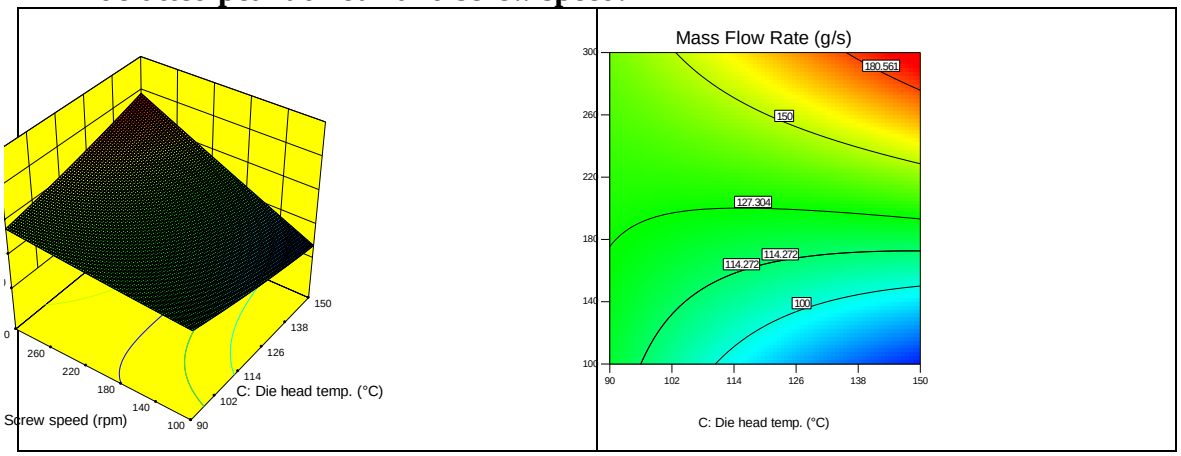

Fig. 13 Response surface and contour plot for mass flow rate as a function of die head temperature and screw speed.

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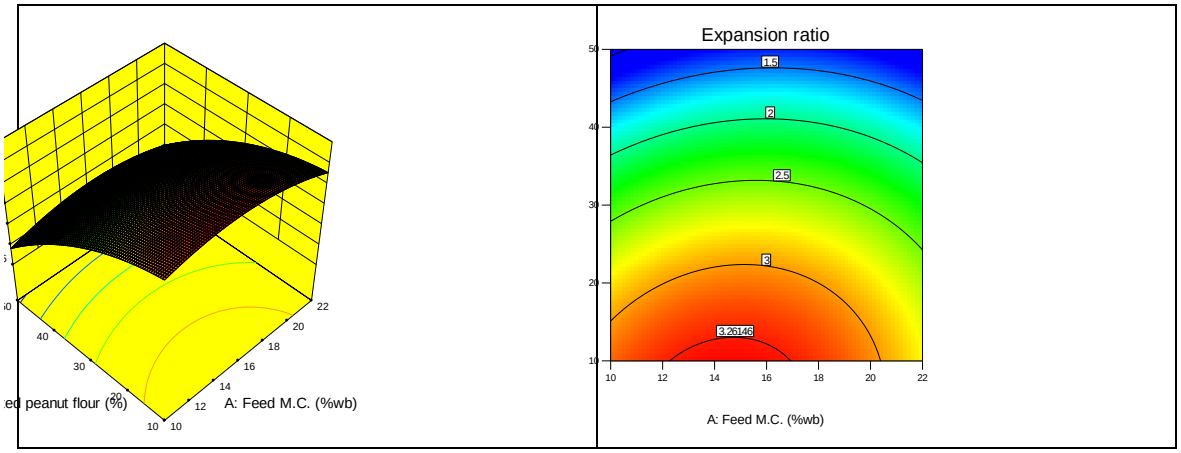

Fig. 14 Response surface and contour plot for expansion ratio as a function of feed moisture content and defatted peanut flour.

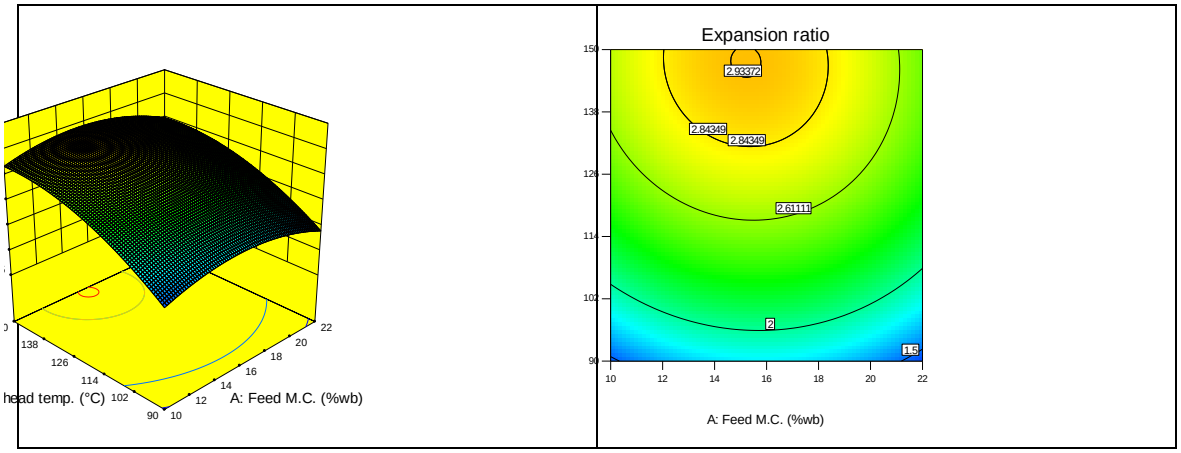

Fig. 15 Response surface and contour plot for expansion ratio as a function of feed moisture content and die head temperature.

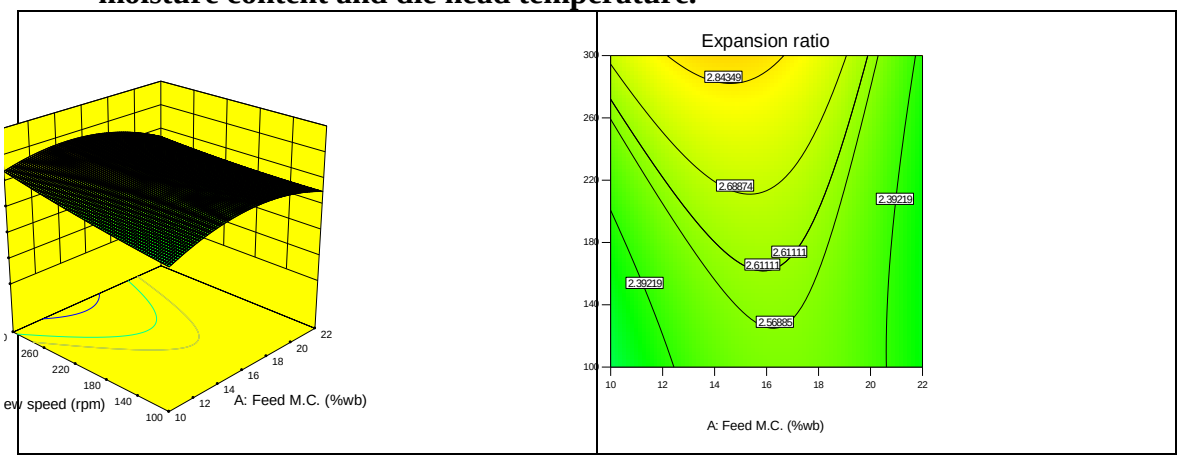

Fig. 16 Response surface and contour plot for expansion ratio as a function of screw speed and feed moisture content.

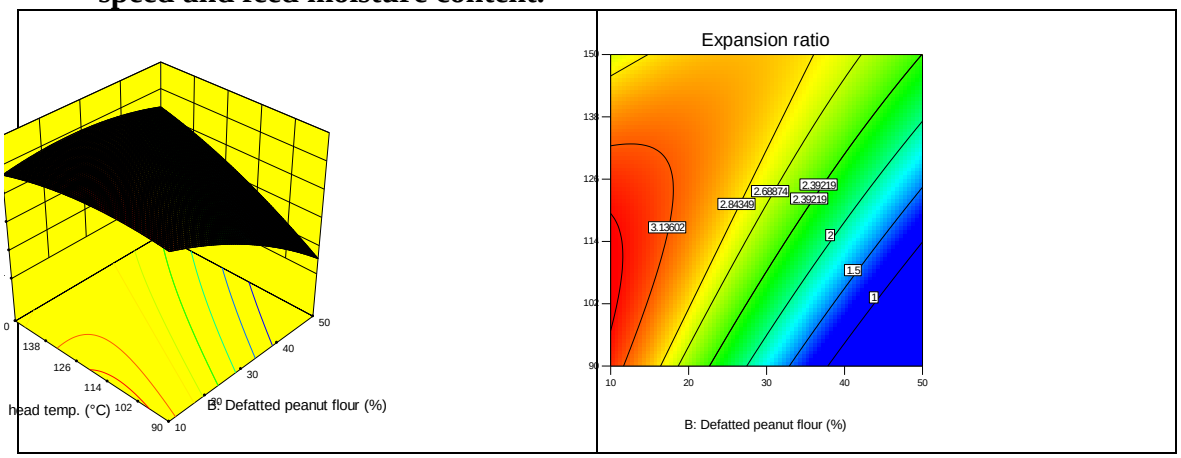

Fig. 17 Response surface and contour plot for expansion ratio as a function of defatted peanut flour and die head temperature.

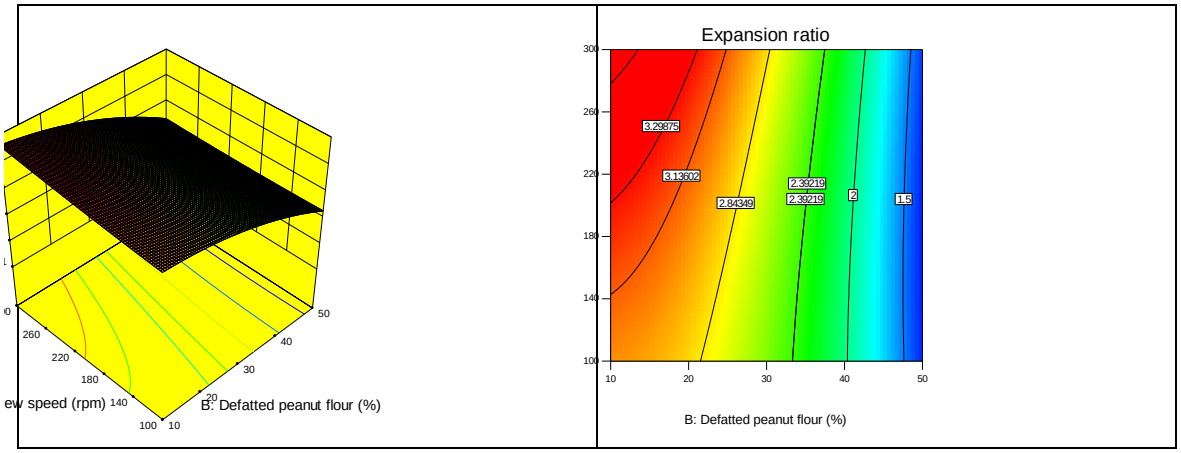

Fig. 18 Response surface and contour plot for expansion ratio as a function of defatted peanut flour and screw speed.

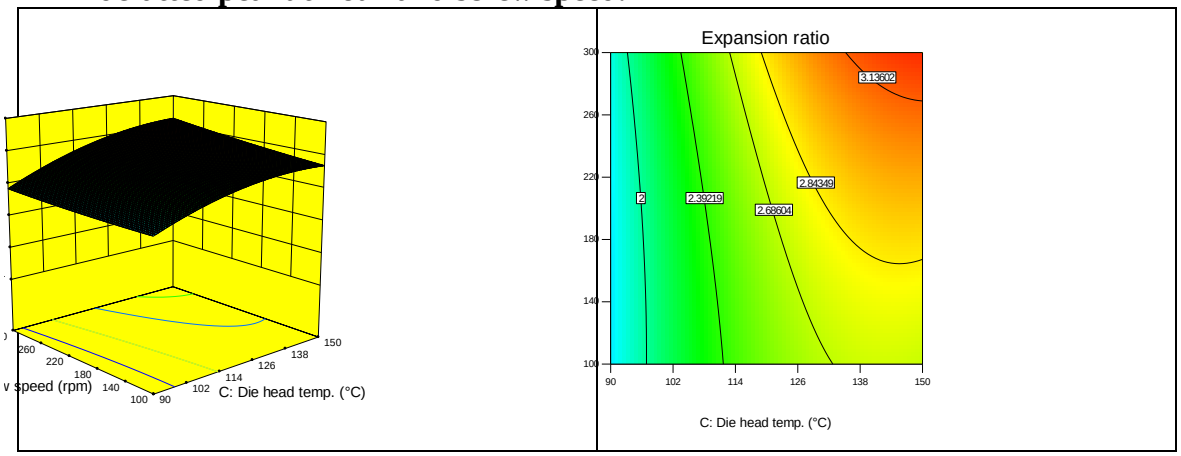

Fig. 19 Response surface and contour plot for expansion ratio as a function of die head temperature and screw speed.

tion Index (WAI)

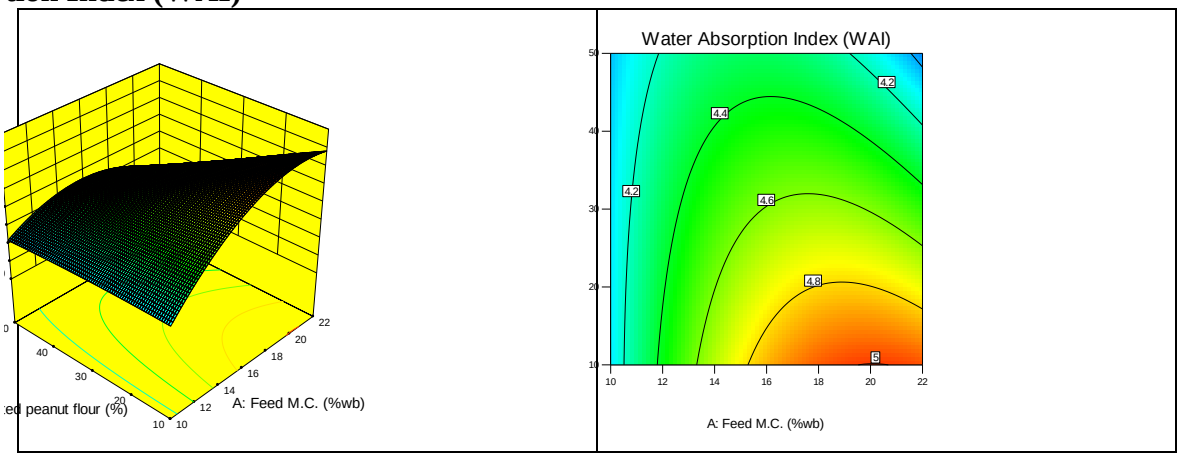

Fig. 20 Response surface and contour plot for water absorption index as a function of feed moisture content and defatted peanut flour.

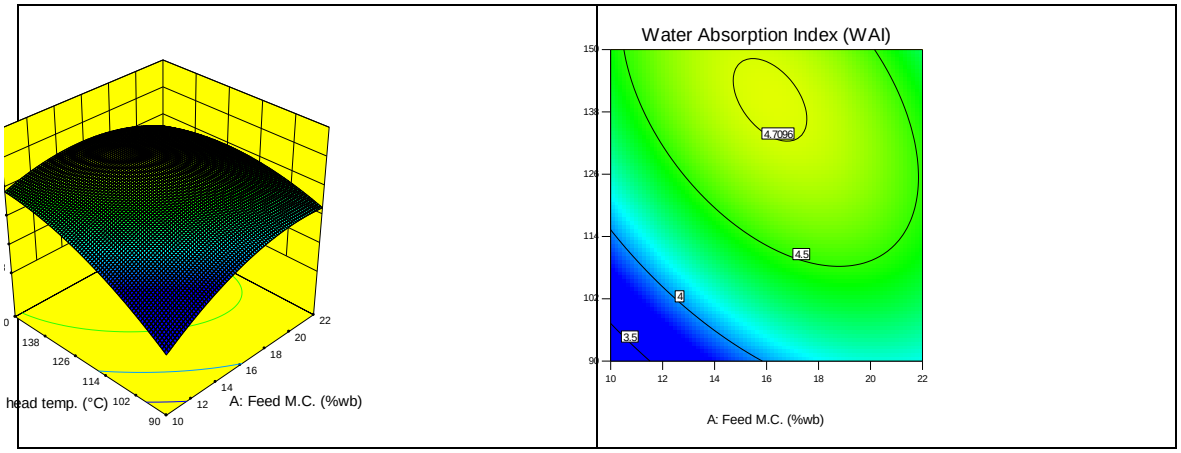

Fig. 21 Response surface and contour plot for water absorption index as a function of feed moisture content and die head temperature.

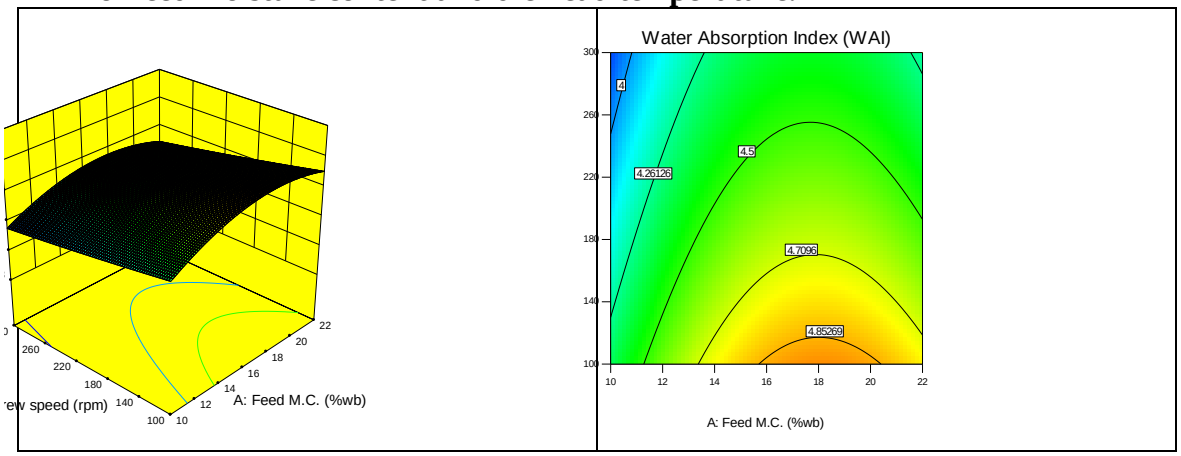

Fig. 22 Response surface and contour plot for water absorption index as a function of screw speed and feed moisture content.

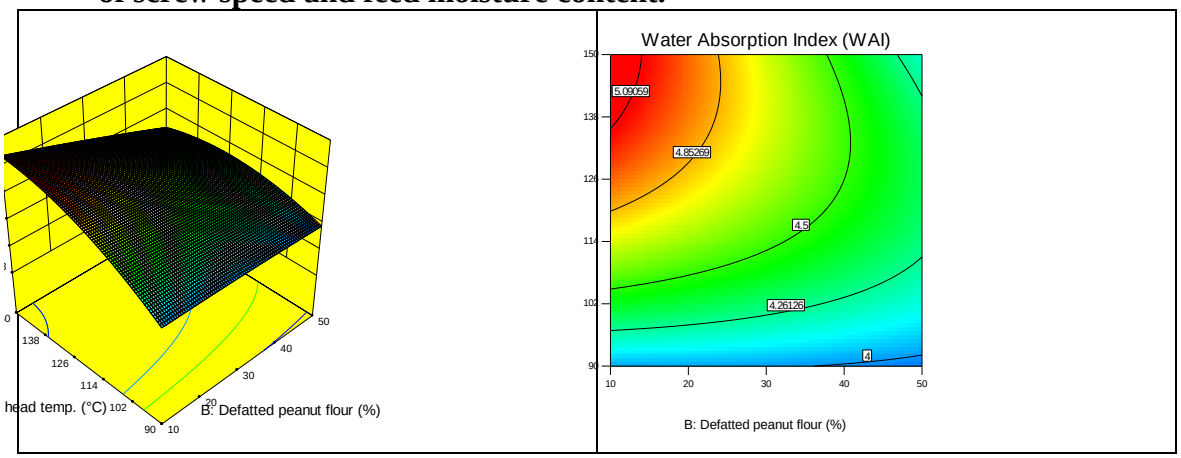

Fig. 23 Response surface and contour plot for water absorption index as a function of defatted peanut flour and die head temperature.

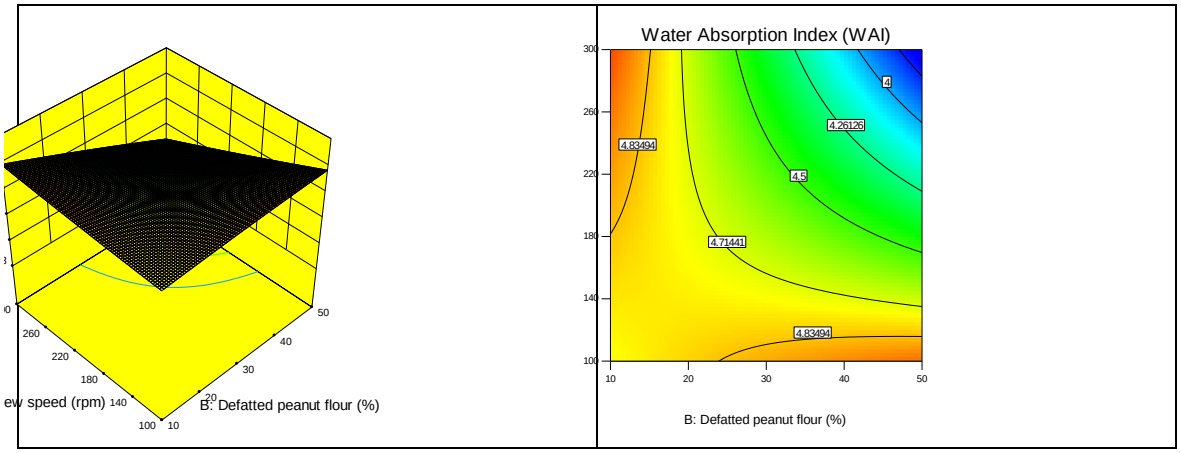

Fig. 24 Response surface and contour plot for water absorption index as a function of defatted peanut flour and screw speed.

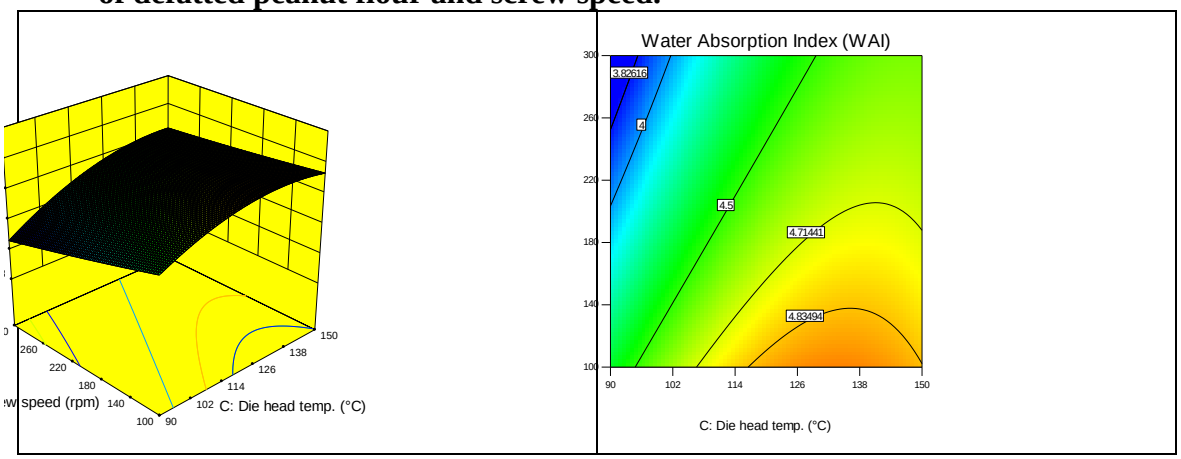

Fig. 25 Response surface and contour plot for water absorption index as a function of die head temperature and screw speed.

g Capacity (WHC)

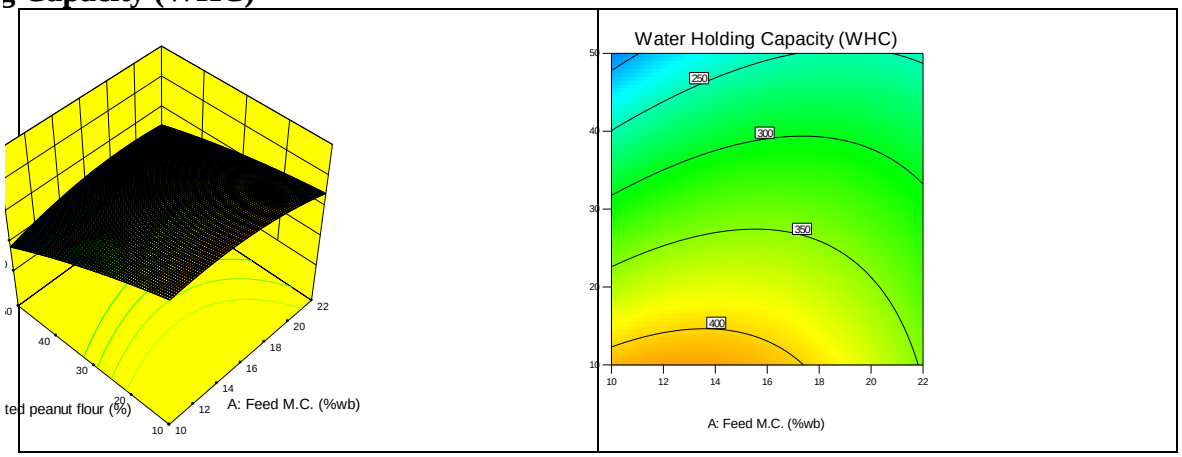

Fig. 26 Response surface and contour plot for water holding capacity as a function of feed moisture content and defatted peanut flour.

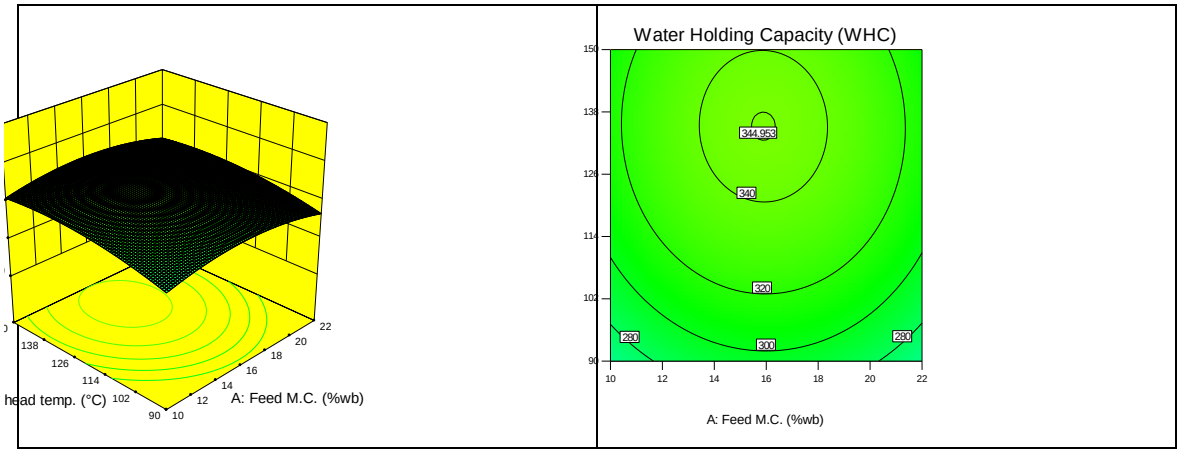

Fig. 27 Response surface and contour plot for water holding capacity as a function of feed moisture content and die head temperature.

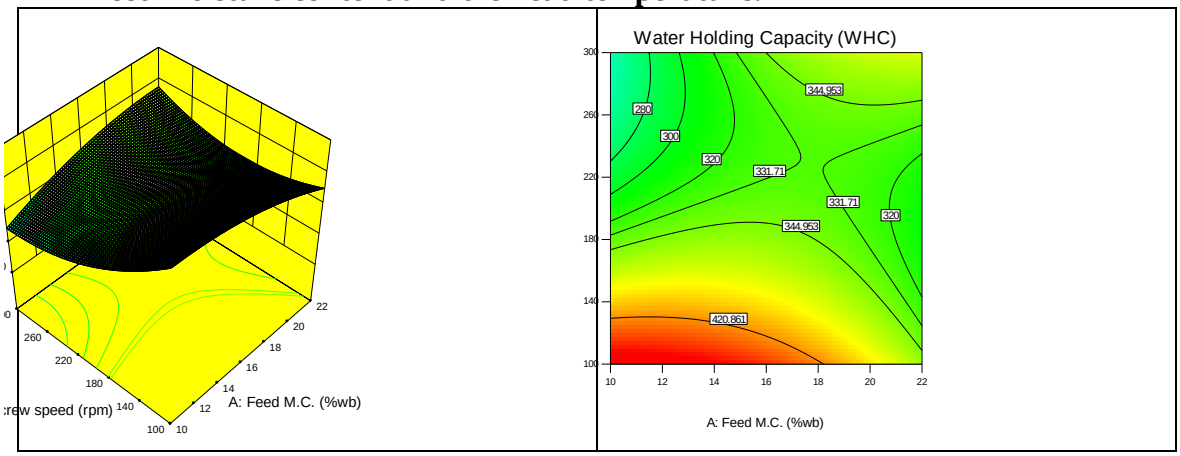

Fig. 28 Response surface and contour plot for water holding capacity as a function of screw speed and feed moisture content.

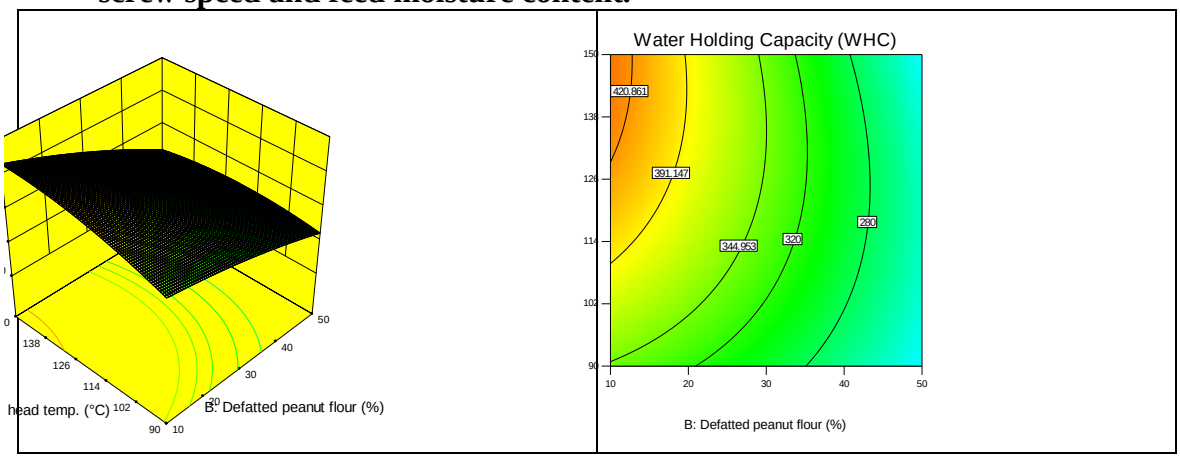

Fig. 29 Response surface and contour plot for water holding capacity as a function of defatted peanut flour and die head temperature.

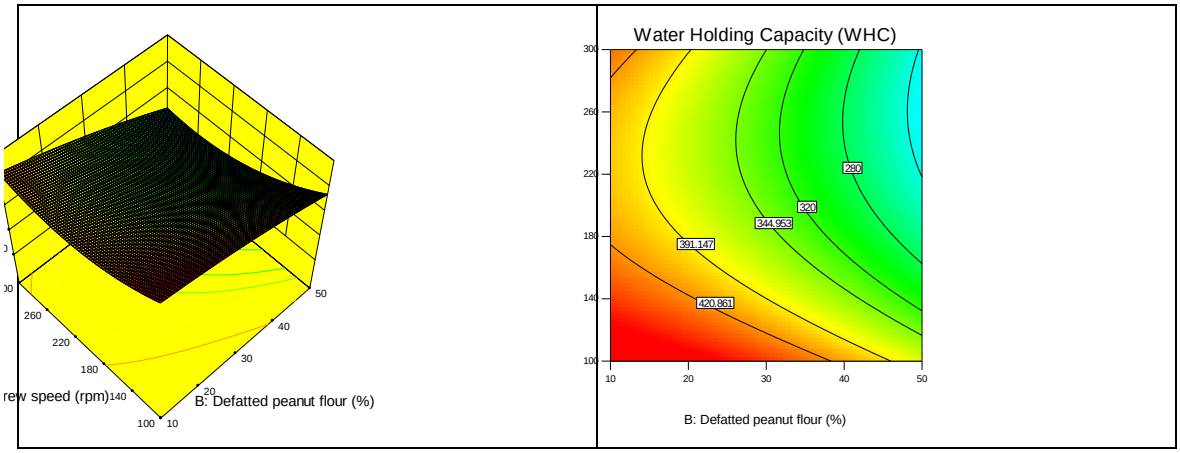

Fig. 30 Response surface and contour plot for water holding capacity as a function of defatted peanut flour and screw speed.

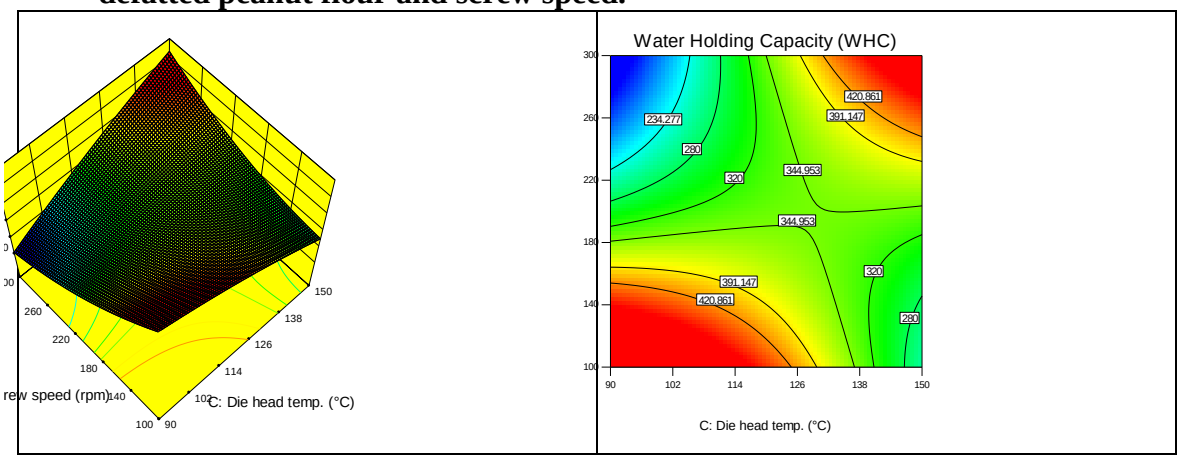

Fig. 31 Response surface and contour plot for water holding capacity as a function of die head temperature and screw speed.

ity Index (WSI)

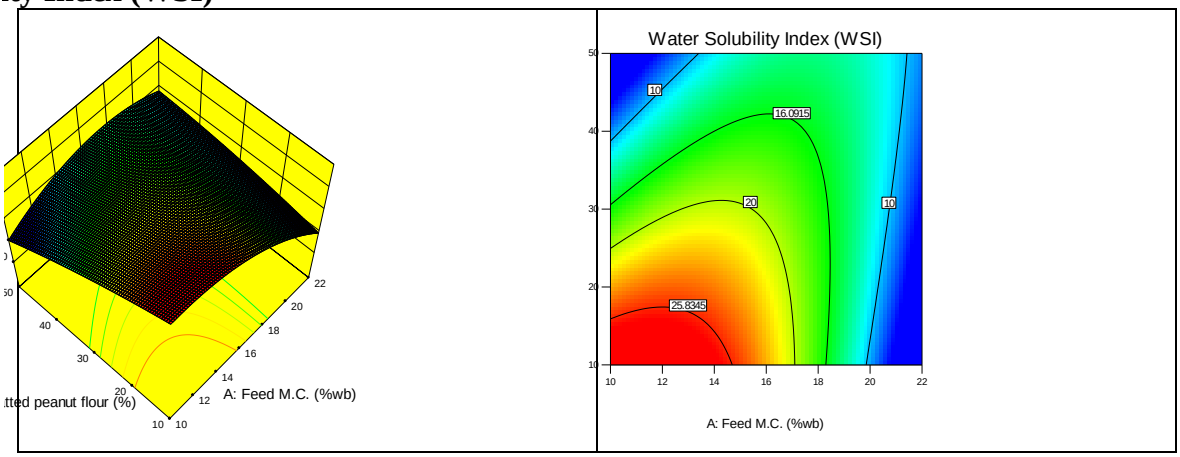

Fig. 32 Response surface and contour plot for water solubility index as a function of feed moisture content and defatted peanut flour.

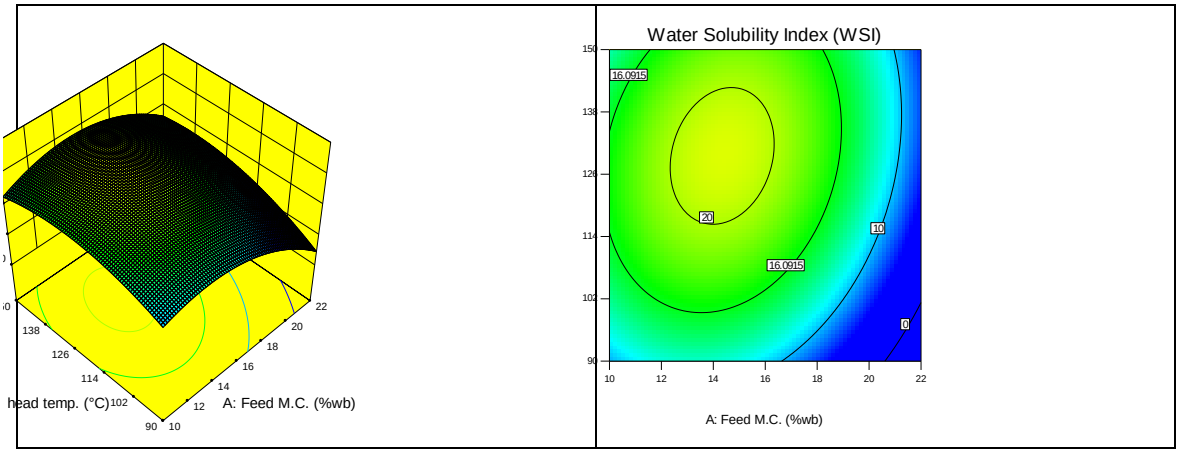

Fig. 33 Response surface and contour plot for water solubility index as a function of feed moisture content and die head temperature.

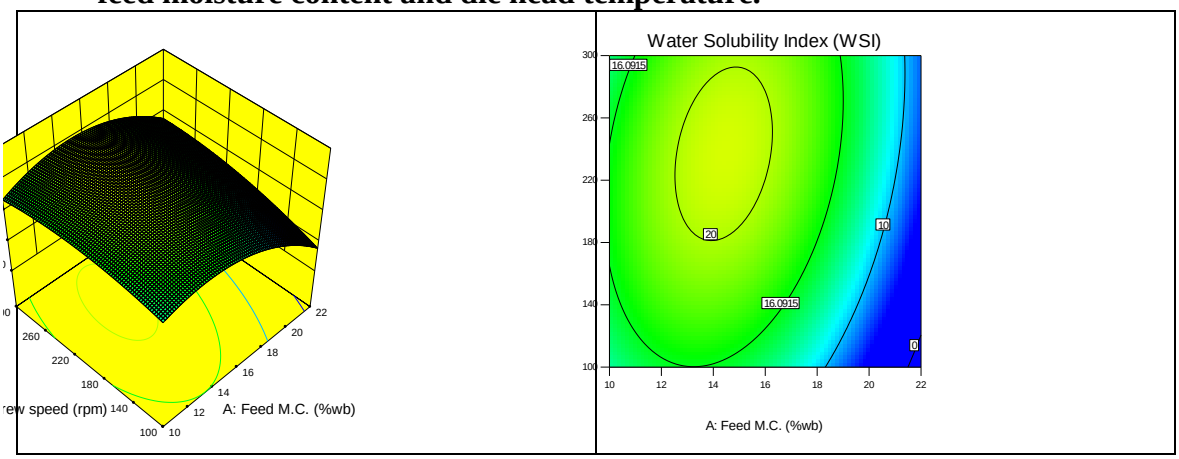

Fig. 34 Response surface and contour plot for water solubility index as a function of screw speed and feed moisture content.

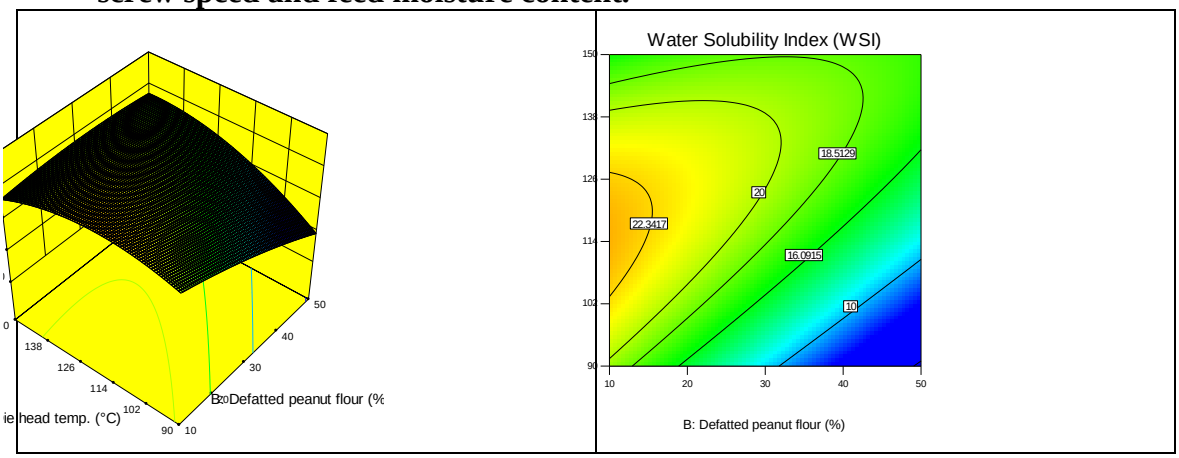

Fig. 35 Response surface and contour plot for water solubility index as a function of defatted peanut flour and die head temperature.

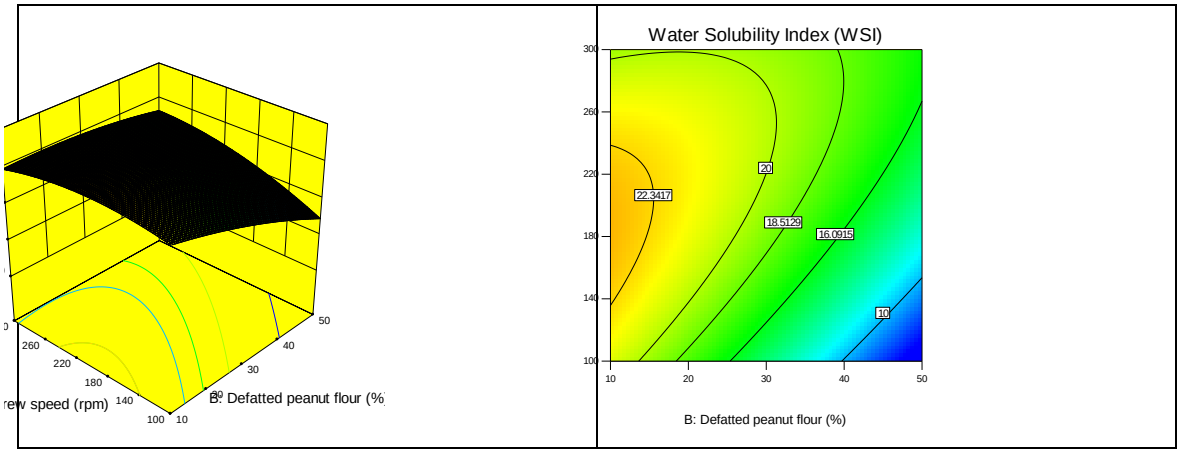

Fig. 36 Response surface and contour plot for water solubility index as a function of defatted peanut flour and screw speed.

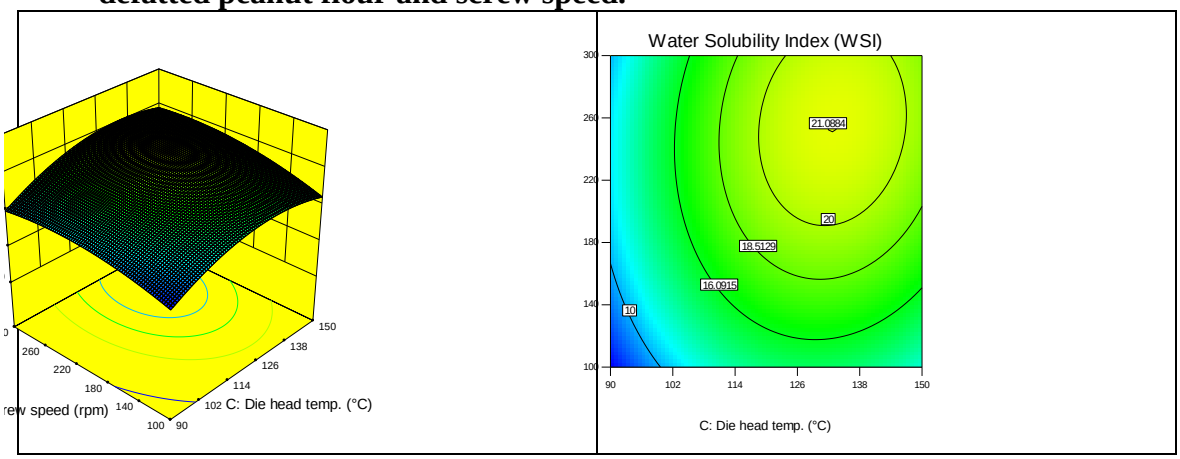

Fig. 37 Response surface and contour plot for water solubility index as a function of die head temperature and screw speed.

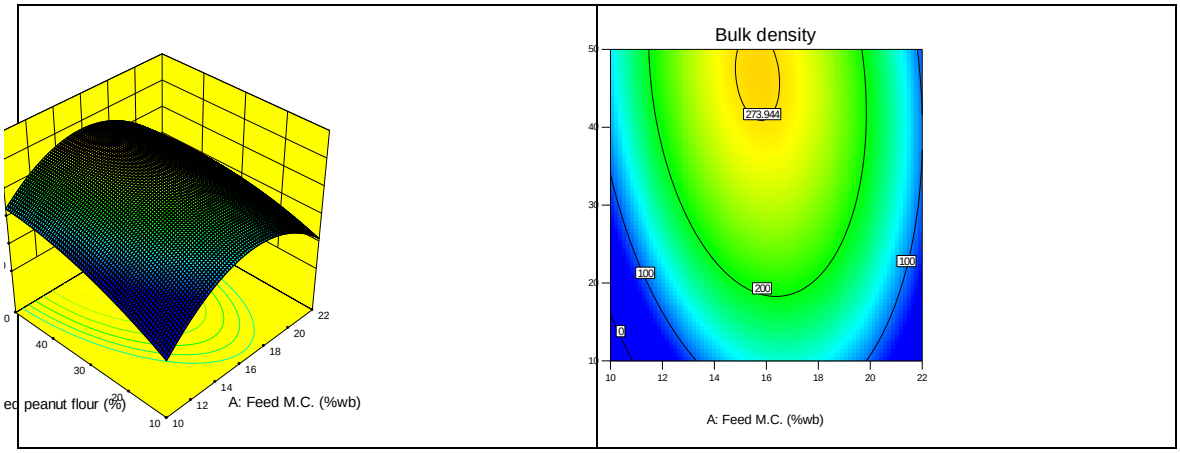

Fig. 38 Response surface and contour plot for bulk density as a function of feed moisture content and defatted peanut flour.

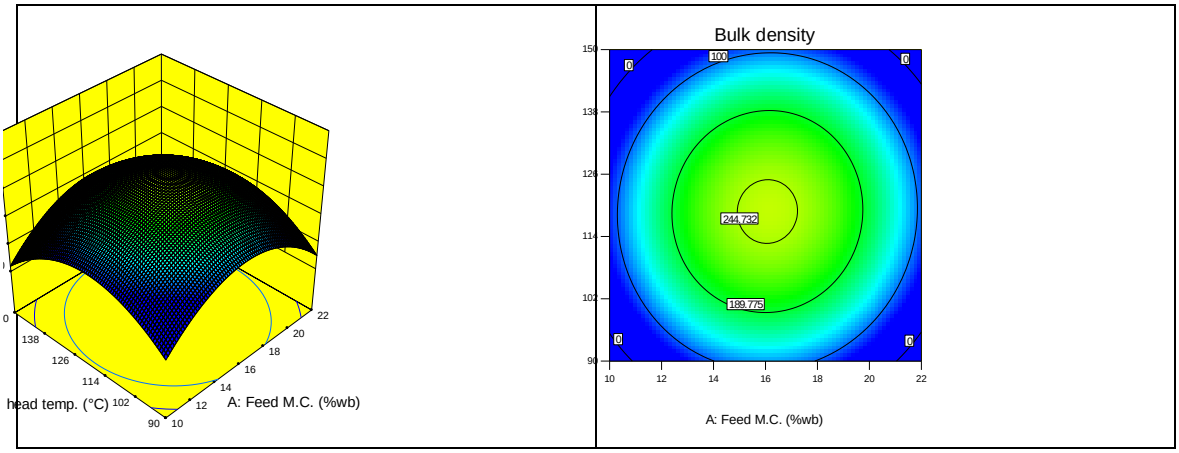

Fig. 39 Response surface and contour plot for bulk density as a function of feed moisture content and die head temperature.

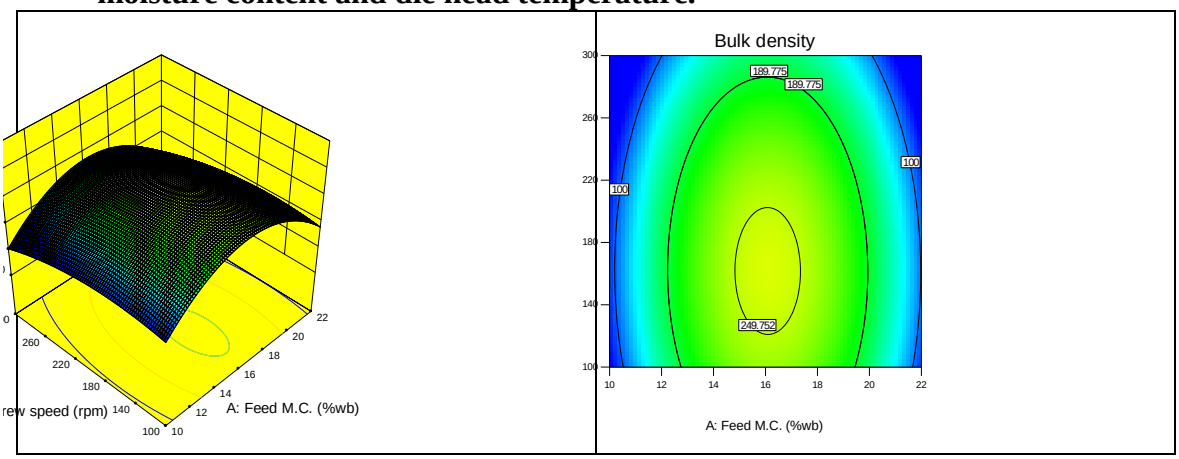

Fig. 40 Response surface and contour plot for bulk density as a function of screw speed and feed moisture content.

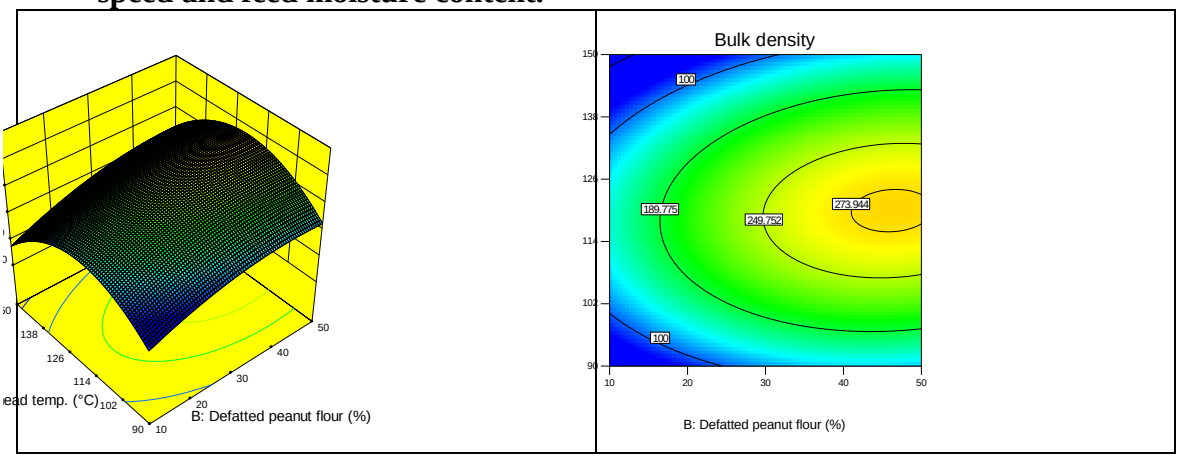

Fig. 41 Response surface and contour plot for bulk density as a function of defatted peanut flour and die head temperature.

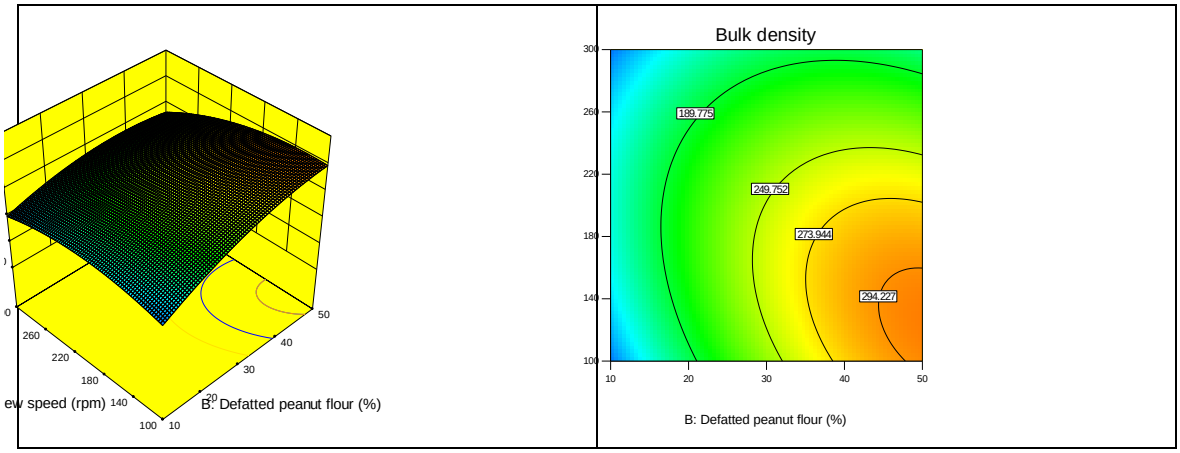

Fig. 42 Response surface and contour plot for bulk density as a function of defatted peanut flour and screw speed.

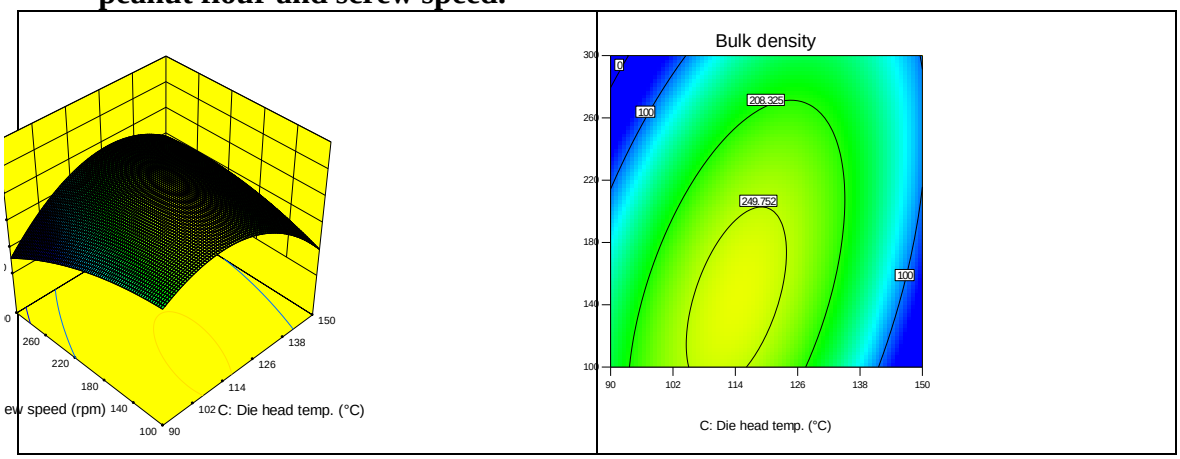

Fig. 43 Response surface and contour plot for bulk density as a function of die head temperature and screw speed.

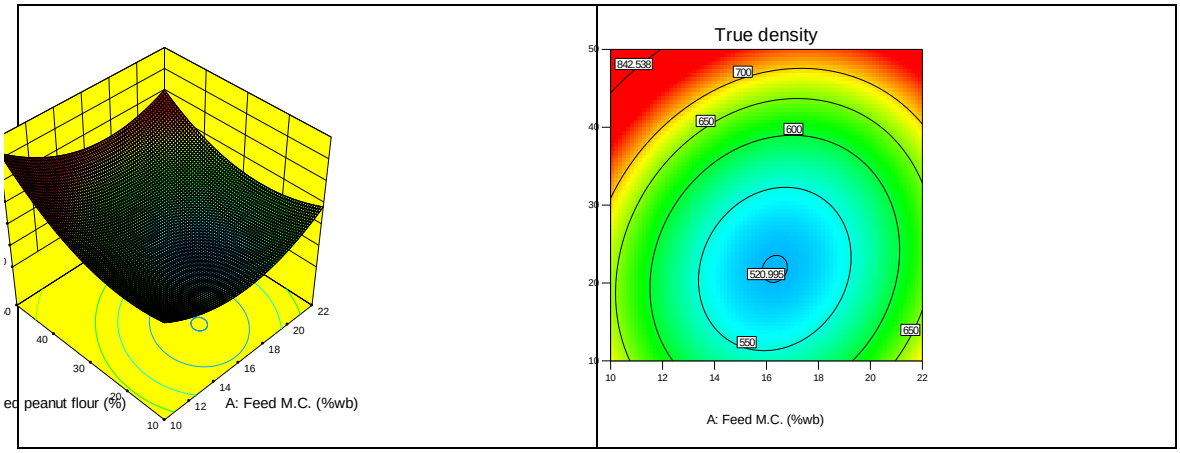

Fig. 44 Response surface and contour plot for true density as a function of feed moisture content and defatted peanut flour.

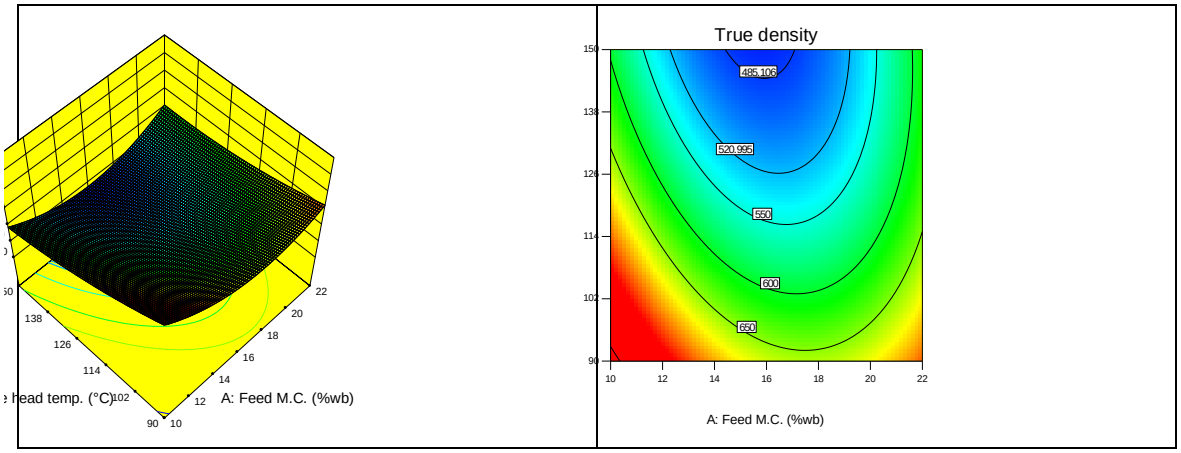

Fig. 45 Response surface and contour plot for true density as a function of feed moisture content and die head temperature.

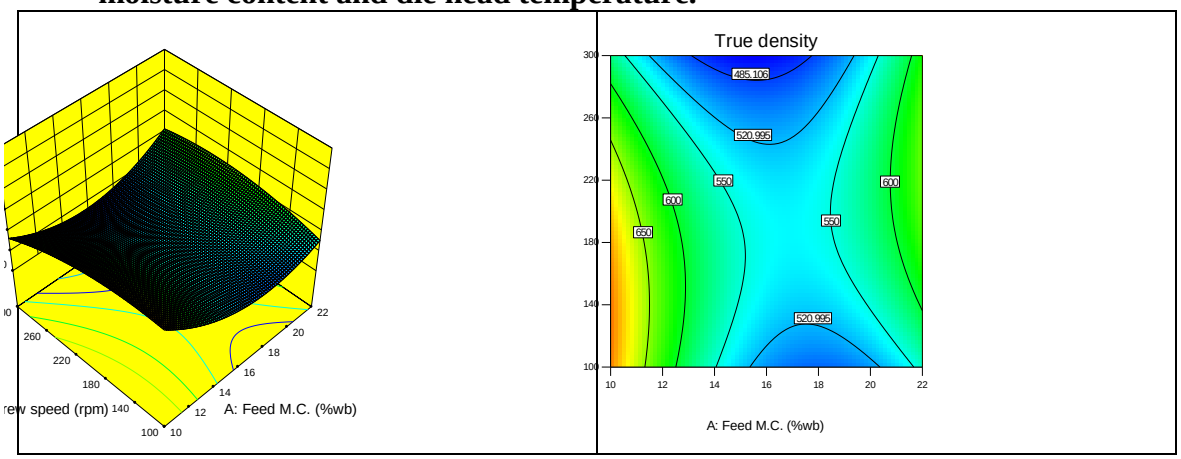

Fig. 46 Response surface and contour plot for true density as a function of screw speed and feed moisture content.

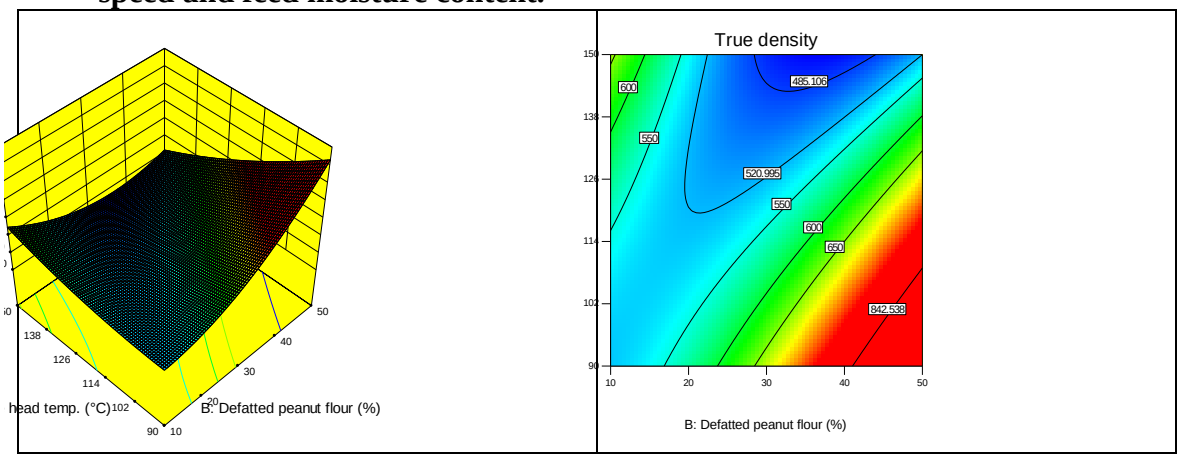

Fig. 47 Response surface and contour plot for true density as a function of defatted peanut flour and die head temperature.

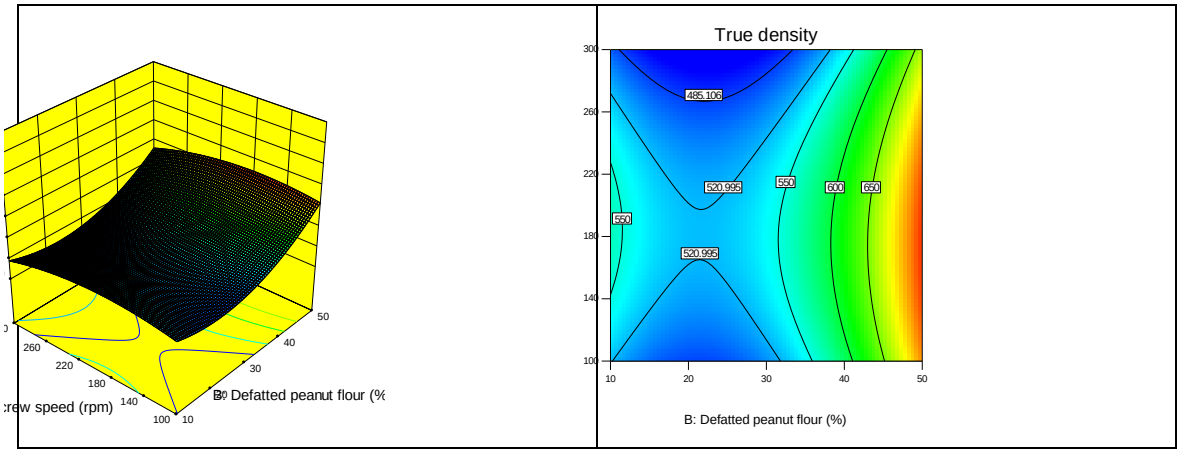

Fig. 48 Response surface and contour plot for true density as a function of defatted peanut flour and screw speed.

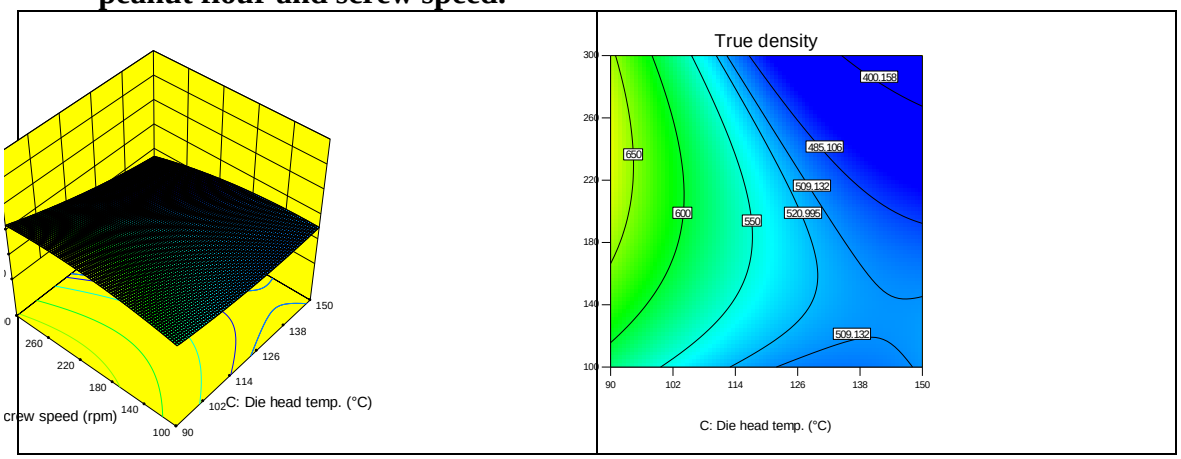

Fig. 49 Response surface and contour plot for true density as a function of die head temperature and screw speed.

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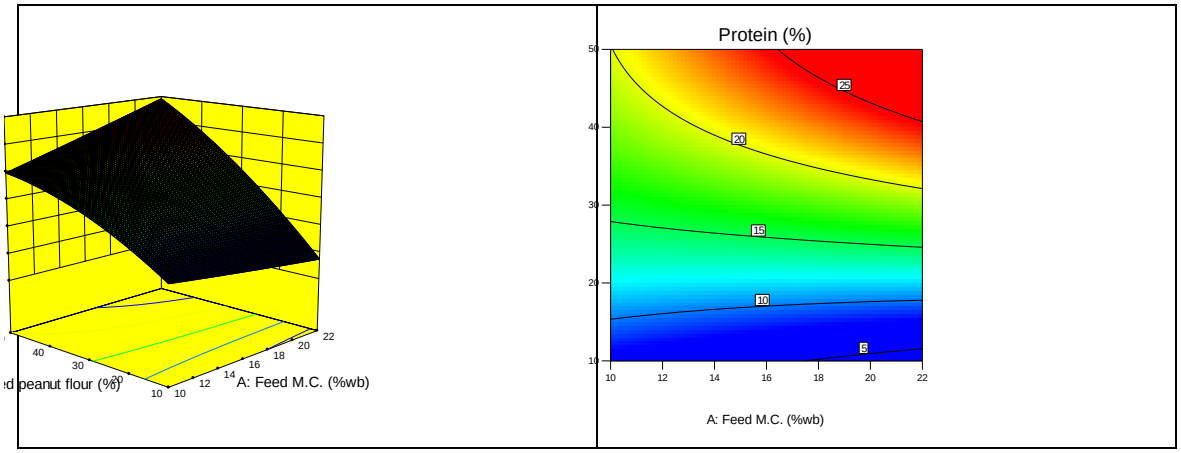

Fig. 50 Response surface and contour plot for protein content as a function of feed moisture content and defatted peanut flour.

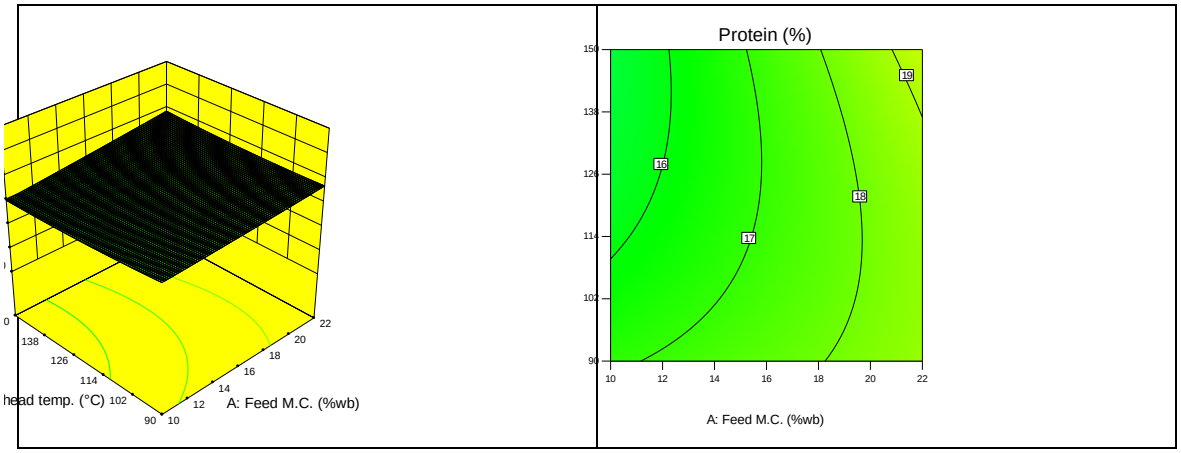

Fig. 51 Response surface and contour plot for protein content as a function of feed moisture content and die head temperature.

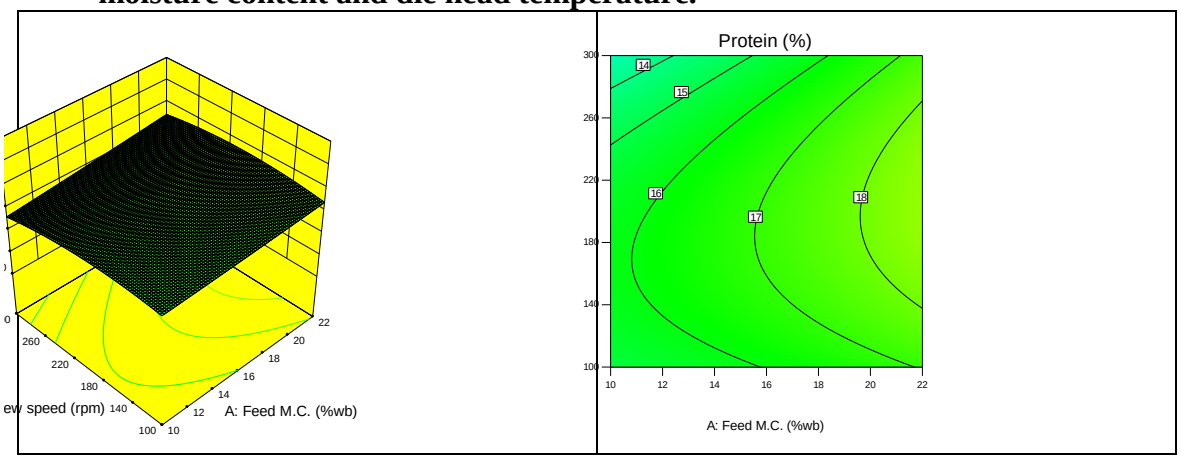

Fig. 52 Response surface and contour plot for protein content as a function of screw speed and feed moisture content.

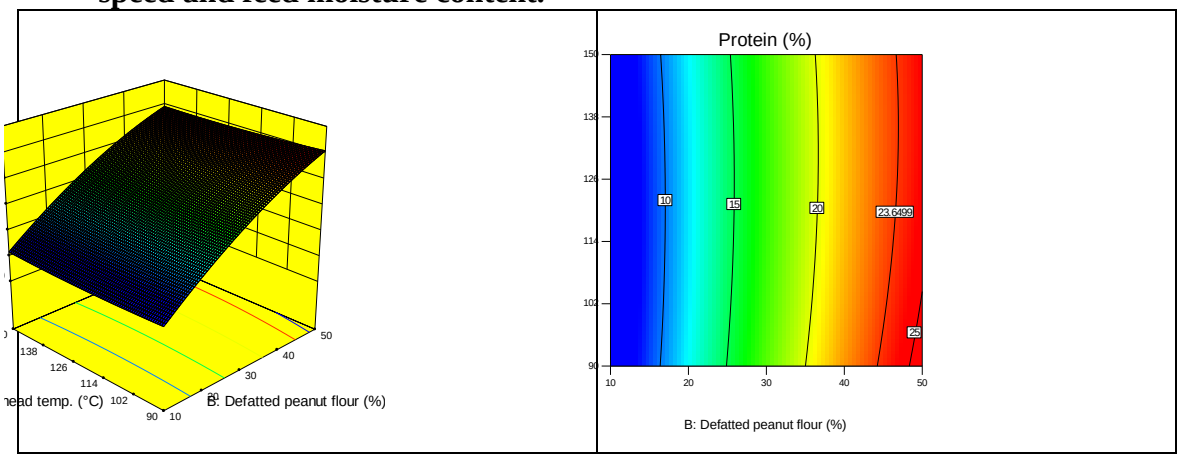

Fig. 53 Response surface and contour plot for protein content as a function of defatted peanut flour and die head temperature.

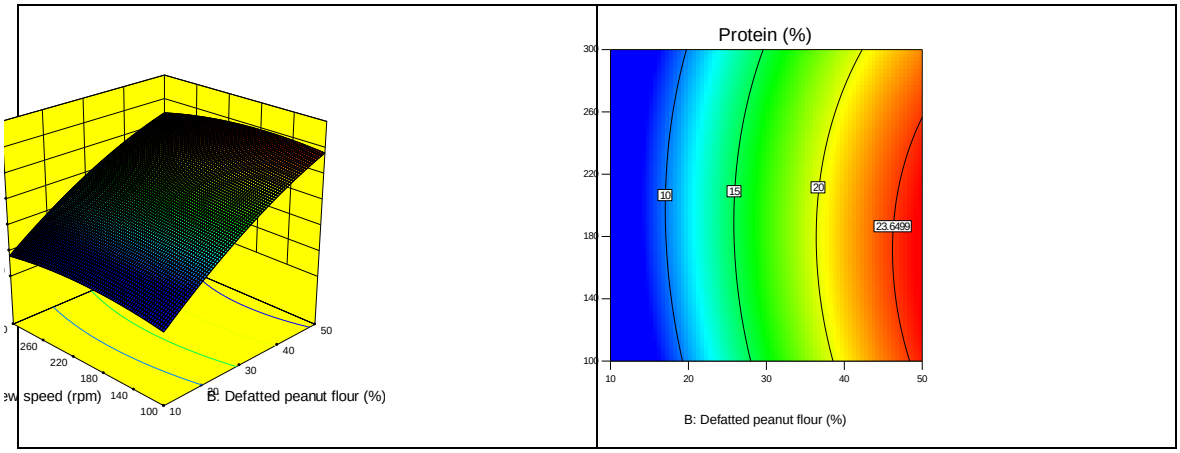

Fig. 54 Response surface and contour plot for protein content as a function of defatted peanut flour and screw speed.

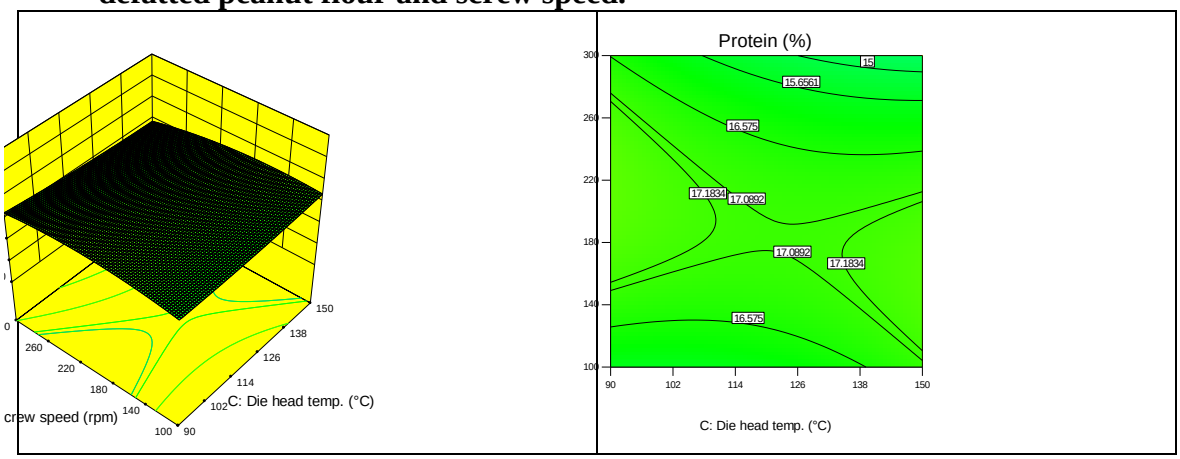

Fig. 55 Response surface and contour plot for protein content as a function of die head temperature and screw speed.

Work to be done

- Data/results of the remaining parameters will be included in the analysis.
- Optimization of process variables will be carried out.
- Results of the data will be validated after conduction the experiment in the laboratory at optimized process variables.

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8. Singh, S., Gamlath, S., and Wakeling, L. (2007). Nutritional aspects of food extrusion: a review. International Journal of Food Science and Technology, 42(8):916-929.
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11. Wójtowicz A., (2007). Ocena wybranych cech jakościowych ekstrudowanych zbożowych kaszek błyskawicznych. Żywność. Nauka. Technologia. Jakość., 4:53, 46-54.

54. Output During Period Under Report

gg. Special attainments/innovations

hh. List of Publications (one copy each to be submitted with RPP-II)

i. Research papers - Nil
ii. Reports/Manuals - Nil
iii. Working and Concept Papers - Nil
iv. Popular articles - Nil
v. Books/Book Chapters - Nil
vi. Extension Bulletins - Nil

ii. Intellectual Property Generation
(Patents - filed/obtained; Copyrights- filed/obtained; Designs- filed/obtained; Registration details of variety/germplasm/accession if any)

jj. Presentation in Workshop/Seminars/Symposia/Conferences
(relevant to the project in which scientists have participated)

kk. Details of technology developed
(Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)

ll. Trainings/demonstrations organized - Nil

mm. Training received - Nil

nn. Any other relevant information – Project is under progress

55. Constraints experienced, if any
- Nil

56. Lessons Learnt
- Nil

57. Evaluation

(a) Self evaluation of the project for the period under report by the PI with rating in the scale of 1 to 10 — 8

(b) Evaluation by PI on the contribution of the team in the project including self

S. No.	Name	Status in the project (PI/CC-PI/Co-PI)	Rating in the scale of 1 to 10

1	Dr. P. R. Davara	PI	8
2	Dr. M. N. Dabhi	Co-PI	8

58. Signature of PI, CC-PI(s), all Co-PIs

59. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of Head of Division/Regional Center / Section

60. Comments of IRC

61. Signature (with specific comments on progress/achievements, shortfall and constraints along with rating of the project in the scale of 1 to 10) of JD (R)/ Director

SUMMARY OF PROGRESS REPORT

1. PH/JU/85/1 Operational research project on Agro- processing center.

At Tadka Pipliya agro processing center, flour milling and oil milling operations were carried out. About 13 ton groundnut was processed and 1500 tins oil were filled. About 8 tons of wheat were cleaned and graded for the farmers. 238 kg of sesame were processed for preparation of sani. 625 kg of raw pulses were processed for preparation of dhal.

At Agro Processing Centre, Virol, about 36 tons of groundnuts were processed for the farmers. About 3 ton of wheat grains were graded for the farmers at the centre. In addition to this, 371 kg of chilly, 49 kg of turmeric and 37 kg of cumin were grinded using spice mill.

At Agro Processing Centre, Loej, about 28 tons of groundnuts were processed for the farmers. About 3 ton of wheat grains were graded for the farmers at the centre.

At new Agro Processing Centre established at Chotila, about 3.5 ton of groundnut were processed.

2. PH/JU/2016/01 Design and development of on farm solar assisted dryer for drying of ground nut pods for longer storage.

Drying experiment was conducted for drying of groundnut pods. Dyring characteristics of groundnut pods dried using farm solar assisted dryer were determined. The local variety GG-20 of Gujarat was tested for its drying characteristics. Performance evaluation of solar dryer under no load as well as full load condition was carried out. This evaluation of solar dryer was made on the basis of temperature and relative humidity at different ports for different velocities. Cost incurred for the fabrication of solar dryer was calculated. Cost economics for drying of groundnut pods was determined. Quality analysis of dried groundnut pods will be carried out.

3. PH/JU/2016/02 To study the effect of different packing materials against Groundnut

Bruchid (*Caryedon serratus* Olivier.) during storage.

Planning the experiment completed. Purchasing the materials and prepared different bags as per treatments. Groundnut pods harvested in kharif season 2016 was purchased from Sagadividi farm, Seed Science Department, JAU, Junagadh. 30 kg pods stored in different bags and kept at room temperature in laboratory. Initial observation Viz, moisture content, germination percent and insect infestation etc. were recorded. Recording of monthly observations data on entomological and physical parameters during storage has been started and continue till storage period. Observation on pest population, percent pod damage and percent moisture content after 4, 5, 6 and 7 months of storage for the different bags were recorded. At the end of 7 months of storage, percentage germination of kernel and total aflatoxin content in the kernel were determined. Based on the observation, it was concluded that, pest population and percent grain damage, moisture content and germination percent, the treatment of PICS bag was found the most effective to protect the groundnut pods from infestation of bruchid beetle up to 7month of storage. The treatment of Closely woven net bags was found next best treatment.

4. PH/JU/2017/01 Forced air curing of onion.

Small scale forced air curing system was fabricated. Experiment trials for curing of onion with and without foliage were carried out using developed curing system. Curing was done for the freshly harvested red variety of onion (GJRO11) and white variety of onion (GJWO3). Cured onions were stored in the onion storage structure. Storage parameters viz. moisture content, weight loss, pyruvic acid, total sugar content, reducing sugar content, total soluble solid, black mold, soft rot, sprouting were observed before the storage and every month of storage period for both the varieties.

5. PH/JU/2017/02 Testing of ozonization against storage insect pest of wheat.

Planning the experiment completed. Purchasing the materials and prepared different bags as per treatments. Wheat was procured from University research station, krishigadh, JAU, Junagadh. 1 kg grains was stored in different bags after treatment of ozonization of wheat and kept at room temperature in laboratory. Monthly observations were recorded on entomological and physical parameters during storage. Statistical analysis and report writing is under progress.

Tentative Technical Programme for the year 2016-2017

Sr. No.	Code No.	Title
1.	PH/JU/85/1	Operational research project on Agro-processing center.
2.	Ongoing Project	ICAR-FCI project - Study on Determining Storage Losses of Food Grains in FCI and CWC Warehouses
3.	Ongoing project PH/JU/16/1/1	Design and development of on farm solar assisted dryer for drying of ground nut pods for longer storage.
4.	Ongoing project PH/JU/16/1/2	To study the effect of different packing materials against Groundnut Bruchid (Caryedon serratus Olivier) during storage.
5.	Ongoing project PH/JU/17/1	Forced air curing of onion.
6.	Ongoing project PH/JU/17/2	Testing of ozonization against storage insect pest of wheat
7.	New Project-I	Design and development of grain treater for enzymatic pre-treatment to pigeon pea grains
8.	New Project-II	Development of high protein extruded product using defatted peanut flour
9.	New Project-III	Extraction of pectinase enzyme from banana peels using *Aspergillus terreus* fungi.
10.	New Project-IV	Low temperature grinding of spices.

Action taken report of Proceeding of 33rd Annual Workshop held at JAU, Junagadh during 23-25, January, 2018

Sr. No.	Experiment	Comments 33rd Workshop	Action
1	Design and development of grain treater for enzymatic pre-treatment to pigeon pea grains.	**Comments/ Recommendations :** Approved with conditions that the commercial availability has to be studied and report may be submitted to PC-unit. AKOLA centre has done similar work. Hence both centre has to discus and come with appropriate technology.	• It was informed by the AKOLA centre that they have not done work on similar line.
2	Development of high protein extruded product using defatted peanut flour	The work was approved as a part of groundnut value chain project, not as separate project. An objective should be added in the values chain project on this aspect.	• This work is considered as a part of value chain on groundnut.
3	Low temperature grinding of spices.	IIT Kharagpur proposed similar project. Low temperature should be defined. On submission of revised proposal, it may be considered for approval in next workshop. Major revision is required and clear methodology should be mentioned.	• Revised proposal is submitted. Methodology and working for low temperature system is changed. Now chilled water/coolant will be circulated. Super mill grinder was approved in EFC and is also purchased and cooling system work is under progress.

NEW PROJECT - 1

NEW INVESTIGATION – I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
PROFORMA FOR PREPARATION OF STATUS REPORT
FOR PROPOSAL OF A NEW RESEARCH PROJECT
(Refer for Guidelines ANNEXURE-XI(A))

1. Institute Name : Junagadh Agricultural University, Junagadh-362001

2. Title of the project : Evaluation of Chimney type Storage structure developed by farmers for onion storage.

3. Type of research project : ~~Basic/Applied/Extension~~/Farmer Participatory/~~Other~~ (specify)

4. Genesis and rationale of the project :

Onion (*Allium cepa L.*) is an important spice vegetable crop, grown almost all over the country, which is seasonal in production, but required round the year. During 2015-16 in India the production area of onion was 1320.0 ('000 HA), production 20931.2 ('000 MT) and the productivity of onions was 15.9 MT/HA. While during 2015-16 in Gujarat the production area was 53.20 ('000 HA), production 1355.78 ('000 MT) and the productivity of onions was 25.48 MT/HA. (Horticultural statistics at a Glance 2017).

Onion is liked and valued throughout the world for its characteristic flavour, taste and pungency. Storage is an important aspect of post-harvest management. The main objective of onion storage is to extend their period of availability. The primary purpose of storage is to arrest the metabolic breakdown and microbial deterioration. The onion is low perishable crop, yet considerable deterioration may occur during storage due to rotting, sprouting, physiological weight loss and microbial attack.

It was reported that during off-season the efficient storage facility for onion plays an important role for the consumers as well as for the producers which ultimately prevents serious losses due to rotting and sprouting. There are different types of storage structures used in different parts of the country. Most of these structures lack in proper ventilation resulting in higher storage losses. The poor aeration and air movement resulted in rise of storage temperature, which in turn adversely affected the product storage physiology and pathology. (Dabhi et al.,2017). As per direct discussion with many farmers / traders of Junagadh, Rajkot, Jamnagar and Porbandar districts, they stored onions for five to six months in chimney type storage structure having least losses. Mainly they stored "Pilli Patti" onions.

A design of chimney type storage structure is low cost and low maintenance. It is also popular in farmers / traders. Recently, Department of Horticulture, communicated with Junagadh Agricultural University, Junagadh to provide a storage structure design of onions with scientific data which is popular in farmers / traders for getting benefit to the farmers / traders for construction of chimney type onion storage structure.

These structures are developed by the farmers, there after there is a need of scientific study for recommendation to other parts of country. As there is no

recommendation from scientific consideration these structures are not considered for government subsidy purpose.

Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered :

(1) Which is the popular onion storage structure design among the farmers / traders of saurashtra region? Why?

Chimney type storage structure design is popular design among the farmers / traders of saurashtra region. Because onions can be stored for 5-6 months with less deterioration as well as one time capital investment without maintenance.

(2) Is this storage structure design is subsidize from the government? Why?

No. Chimney type storage structure design is not subsidized from the government. Because Department of horticulture, Govt. of Gujarat does not have scientific data regarding storage losses of onions.

5. Critical review of present status of the technology at national and international levels along with complete references :

At national and international level, various studies were conducted on onion storage & its structures. In saurashtra region, mainly chimney type onion storage structure is popular in farmers and traders of onions. But Department of Horticulture, Government of Gujarat do not have scientific data regarding onion storage in chimney type structure. So, a policy regarding subsidy to the chimney type storage structure is not applied in this area. 2 years data analysis in chimney type onion storage structure will create a strong database regarding onion storage in chimney type structure and a recommendation will be helpful to create business oriented atmosphere and new employment opportunities. (As per the conversation with the Horticultural dept., Govt. of Gujarat).

6. Expertise available with the investigating group/Institute :

Department of Horticulture & Vegetable Research Centre, Junagadh Agricultural University, Junagadh.

7. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues :

Patent might be obtained as per the rules of patent issuing authority.

8. (a) Expected output

1. Subsidy plays a major part in farmer’s life. A recommendation regarding scientific data about onion storage will be forwarded to the Horticultural department, Gujarat government. Based on this, subsidy amount will be fixed in an onion storage structure.

2. A survey regarding post harvest losses in chimney type onion storage will be studied. Farmers and traders will be benefitted by this.

b. Clientele/Stake holders (including economic and socio aspects)

A recommendation will be useful for the farmers and traders.

9. Signatures

[Project Leader] [Co-PIs] ……

11. Comments and signature

Saurashtra is a leading region in Gujarat on the cultivation and production of onion. Such kind of project will be helpful to create business oriented atmosphere and new employment opportunities with the help of government. Departmental research activities also get a new direction.

[Head of Division]

ANNEXURE- II
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
RESEARCH PROJECT PROFORMA FOR INITIATION OF A RESEARCH PROJECT (RPP - I)
(Refer for Guidelines ANNEXURE-XI (B)

1. Institute Project Code (to be provided by PME Cell)

2. Project Title : Evaluation of Chimney type Storage structure developed by farmers for onion storage.

3. Key Words : Onion storage structure (Chimney type), Post harvest losses, Dept. of Horticulture, Govt. of Gujarat, Subsidy for new construction.

(a) Name of the Lead Institute : AICRP on Post Harvest Engg. & Technology,
Dept. of Processing & Food Engineering,
College of Agril. Engg. & Technology,
Junagadh Agricultural University, Junagadh

(b) Name of Division/ Regional Center/ Section : Junagadh-362001

4. (a) Name of the Collaborating Institute(s), if any : - Nil -

(b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : - Nil -

5. Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)

Sr. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Prof. A. M. Joshi	P.I.	50%	Survey, Collection and Full Fledge Experimental work.
2.	Er.H.R.Sojaliya	Co – P.I.	30%	Helping to conduct the experiment
3.	Dr. M. N. Dabhi	Co – P.I.	20%	Overall guidance & supervision, Effective communication with farmers and Horticultural Dept., Govt. of Gujarat.

6. Priority Area to which the project belongs : Post harvest technology

(If not already in the priority area, give justification)

7. Project Duration: Date of Start : **April-2019**

Likely Date of Completion **: December-2020**

8. (a) Objectives :

1. To study microbial diseases produced in onions during storage.
2. To study moisture content & sprouting of onions during storage of onions.
3. To identify the extent of onion losses during storage.

(b) Practical utility : (i) Farmers will be the immediate beneficiary.

(ii) To create business oriented atmosphere and new job opportunities.

9. Activities and outputs details

Objective wise	**Activity**	**Month & Year of**		**Output monitorable target(s)**	**% to be carried out in different years**		**Scientist(s) responsible**
		Start	**Comp-letion**		1	2	
1. To study microbial diseases produced in onions during storage.	Monthly observations regarding black mould and soft rot diseases in onions will be carried out.	**1st year**		Output will be obtained with best of knowledge and efforts for 2 years. So, a strong database & technology obtained will be success-fully transferred to the society.	50 %	50 %	1. Prof. A.M. Joshi 2. Dr. M. N. Dabhi 3. Er. H. R. Sojaliya
		May – 2019	October-2019				
		2nd Year					
		May – 2020	October-2020				
2. To study moisture content & sprouting of onions during storage of onions.	Physical parameters like moisture content, temperature and sprouting of onions will be observed.	**1st year**					
		May – 2019	October-2019				
		2nd Year					
		May – 2020	October-2020				
3. To identify the extent of onion losses during storage.	An evaluation regarding post harvest losses in onions will be observed.	**1st year**					
		May – 2019	October-2019				
		2nd Year					
		May – 2020	October-2020				
4. Data Analysis & Report Writing	2 years research work needed pooled work of data analysis and a recomm-endation will be carried out.	November –2020	Decembe r - 2020				

10. Technical Programme (brief)

Onion (*Allium cepa L.*) is an important spice vegetable crop, grown almost all over the country, which is seasonal in production, but required round the year. India is the second largest onion growing country in the world (www.krishikosh.egranth.ac.in) and Gujarat is the third largest onion producing state. (www.agriexchange.apeda.gov.in). There are different types of storage structures used in different parts of the country. Chimney type onion storage structure is very popular in saurashtra region. Many farmers, traders & entrepreneurs used such an onion storage structure for long and safe storage of onions. However, government does not have scientific data regarding post harvest losses of onions during storage in chimney type storage structure. So, subsidy amount was not applicable from government to the farmers / traders for construction of new chimney type storage structure in onions. (Dy. Director (Horti.), Junagadh, Gujarat letters no. 1664-65 dated : 19/05/18 & 2221-22 dated : 29/06/18)

Two years technical programme will be carried out for the better data analysis. Total 10 chimney type onion storage structures in 5 different villages were selected. Selected villages are Vadal, Sanosara (Junagadh district), Bhayavadar (Rajkot district), Jamjodhpur (Jamnagar district) & Rana Khirasara (Porbandar district). These storage structures were developed by farmers and every year they stored the onions. Onion samples will be drawn from the storage structures and the monthly observations regarding microbial and physical parameters will be carried out.

Data analoger will be placed at storage structures and physical parameter like temperature will be measured at monthly time interval. Sprouting, moisture content and microbial parameters like intensity of black mould and soft will be also measured in onion samples at monthly time interval.

Objectives :

1. To study microbial diseases produced in onions during storage.
2. To study moisture content & sprouting of onions during storage of onions.
3. To identify the extent of onion losses during storage.

Possible Outputs :

- A recommendation about chimney type onion storage structure will be provided to the society.
- Department of Horticulture, Govt. of Gujarat might be made a policy regarding subsidy in storage structure and farmers / traders will be benefitted.

References :

- Horticultural Statistics at a Glance 2017, Horticulture Statistics Division, Department of Agriculture, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India.
- Dy. Director (Horti.), Junagadh, Gujarat. Letters no. 1664-65 dated : 19/05/18 & 2221-22 dated : 29/06/18
- Mukesh Dabhi and Nagin Patel. 2017. Effect of Storage Ventilation on Bulb Disease of Onion. Advances in Food Science and Engineering, Vol. 1, No. 3. pp:100-106.
- Wright P.J. and Triggs C.M. 2004. Effects of cultural practices at harvest on onion (*Allium cepa*) bulb quality and incidence of bacterial soft rot and fungal

moulds after simulated shipping. New Zealand Journal of Crop and Horticultural Science, 2004, Vol. 32: 185-192.

- Mahmud, M. S. and M. S. Monjil. 2015. Storage diseases of onion under variable conditions. Progressive Agriculture 26:45-50.
- Malenkovic, I. Z., L. M. Djurovka and R. Trajkovic. 2009. The effect of long term storage on quality attributes and storage potentials of different onion cultivars. Acta Hort., (ISHS) 830:635-642.

11. financial Implications (` in Lakhs)

(A) Financed by the institute

11.1 Manpower (Salaries / Wages)

Sr. No.	Staff Category	Man months	Cost
1.	Scientific	23	19,60,000
2.	Technical	21	9,50,000
3.	Supporting	05	1,00,000
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	49	30,10,000

11.2 Research / Recurring Contingency

S. No.	Item	Year(1)	Year (2)	Total
4.	Consumables	5,000	5,000	10,000
5.	Travel	5,000	5,000	10,000
6.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--
7.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--
8.	Animal/Green house/Computer Systems/Machinery Maintenance	--	--	--
9.	Miscellaneous(Other costs)	5,000	5,000	10,000
	Total(Recurring)	15,000	15,000	30,000

Justification : Chemical as consumables are necessary for the determination of microbial growth. Travelling expenditure will be carried out for the samples collection.

11.3 Non-recurring (Equipment)

S. No.	Item	Year (1)	Year (2)	Year (3)…	Total
1.	--	--	--	--	--

2.	--	--	--	--	--
	Total (Non-recurring)	--	--	--	--

Justification : ----------

11.4 Any Other Special Facility required (including cost) :

S. No.	Item	Year (1)	Year (2)	Total	Remarks
1.	--	--	--	--	--
2.	--	--	--	--	

11.5 Grand Total (11.1 to 11.4)

Item	Year (1)	Year (2)	Total
Grand Total	15,20,000	15,20,000	30,40,000

(B) Financed by an organization other than the Institute (if applicable) : - Nil -

(i) Name of Financing Organization

(ii) Total Budget of the Project

(iii) Budget details

Sr. No.	Item	Year(1)	Year(2)	Total
1	Recurring Contingency			
	Travelling Allowance	--	--	--
	Workshops	--	--	--
	Contractual Services/ Salaries	--	--	--
	Operational Cost	--	--	--
	Consumables	--	--	--
2	Non - Recurring Contingency			
	Equipment	--	--	--
	Furniture	--	--	--
	Vehicle	--	--	--
	Others (Miscellaneous)	--	--	--
3	HRD Component			
	Training	--	--	--
	Consultancy	--	--	--
4	Works (i) New (ii) Renovation	--	--	--
5	Institutional Charges	--	--	--

12. Expected Output : A recommendation will be useful for the farmers, processors / traders.

13. Expected Benefits and Economic Impact :

(i) A recommendation will be useful for getting subsidy in construction of new chimney type storage structure of onions.

(ii) Farmers will be the immediate beneficiary.

14. Risk Analysis : Microbial culture is involved here. So, a qualified person is necessary to handle the live object.

15. Signature :

Project Leader Co-PI-I Co-PI-II

16. Signature of HoD

17. Signature of JD (R)/ Director

ANNEXURE - III
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
CHECKLIST FOR SUBMISSION OF RPP-I
(Refer for Guidelines ANNEXURE-XI(C)

1. Project Title : Evaluation of Chimney type Storage structure developed by

farmers for onion storage.

2. Date of Start & Duration : April – 2019 to December - 2020

3. Institute Project [√] or Externally Funded [ ]

4. Estimated Cost of the Project : 30,40,000/- INR

5. Project Presented in the Divisional/Institutional Seminar? Yes / ~~No~~ [√]

6. Have suggested modifications incorporated? ~~Yes~~ / No [√]

7. Status Report enclosed ~~Yes~~ / No

8. Details of work load of investigators in approved ongoing projects:

Project Leader				Co-PI – I				Co-PI – II…			
Proj. Code.	% Time spent	Date of start	Date of completion	Proj. Code.	% Time spent	Date of start	Date of completion	Proj. Code.	% Time spent	Date of start	Date of completion
- Nil -				- Nil -				PH/JU/ 85/1	10 %	June-2016	June-2019
								PH/JU/ 2016/ 01/02	20 %	March-2016	January-2019
								PH/JU/ 2017/02	20 %	June-2017	January-2020

9. Work Plan/Activity Chart enclosed [√] Yes / ~~No~~

10. Included in Institute Plan Activity [√] Yes / ~~No~~

11. Any previous Institute/Adhoc/Foreign aided projects on similar lines? ~~Yes~~ / No [√]

12. New equipment required for the project ~~Yes~~ / No [√]

13. Funds available for new equipment ~~Yes~~ / No [√]

14. Signatures

Project Leader Co-PI-I Co-PI-II Co-PI–n

HOD/PD/I/c

ANNEXURE - IV
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
APPRAISAL BY THE PMECELL OF RPP-I
(Refer for Guidelines ANNEXURE-XI (D)

1. Institute Name : AICRP on Post Harvest Engg. & Technology, Junagadh Agril. University, Junagadh
2. Project Title : Evaluation of Chimney type Storage structure developed by farmers for onion storage.
3. On scale 1-10 give score to (a) to (j)

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. Was there any other project carried in the past in the same area/topic?

Yes ☐ No ☐

If yes, list the project numbers.

5. Signature of PME Cell Incharge

NEW PROJECT - 2

NEW PROJECT – IV

ANNEXURE - I

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PROFORMA FOR PREPARATION OF STATUS REPORT FOR PROPOSAL OF A NEW RESEARCH PROJECT
(Refer for Guidelines ANNEXURE-XI(A))

1. **Institute Name** : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh
2. **Title of the project** : Low temperature grinding of spices.
3. **Type of research project**: ~~Basic/~~Applied~~/Extension/Farmer Participatory/Other~~ (specify)
4. **Genesis and rationale of the project** :

Spices are important agricultural commodities throughout the world due to their high unit price. India is 'The Land of Spices' and the glory of Indian spices are known throughout the world. Spices and condiments are vegetable products or mixtures thereof free from extraneous matter, used for flavoring, seasoning and imparting aroma in foods. The term applies equally to the product in the whole form or in the ground form. It is, therefore, necessary to give due attention to this commodity with particular reference to quality and value addition (Purthi, 1998).

The term 'grinding' has become generic in common usage (Perry, 1950). In the present study, the terms grinding and 'size reduction' are used as synonyms though the former has been used here because of its common usage. Grinding is a very important step in the post-harvest processing of spices requiring special attention in order not to lose the aroma and flavour compounds present in them (Gopalkrishnan *et al*., 1991). Spices are ground at one stage or the other before consumption though whole spices are also used in culinary practices to a certain extent. Spices are ground either for direct use or making value-added products, such as, ground spices, mixes, oleoresins and spice oil extract which have vast industrial applications (Anon., 2001).

5. **Knowledge/Technology gaps and justification for taking up the present project including the questions to be answered**

The main aim of spice grinding is to obtain smaller particle size with good product quality regarding flavour and colour (Singh and Goswami, 1999).

In conventional grinding of spices, frictional heat is generated in the grinder due to high oil content. During grinding, the temperature of the product rises to a high level which depends upon the oil and moisture content, but it loses a significant fraction of its volatile oil due to this temperature rise. The fat in spices poses extra problems and is an important consideration in grinding. During grinding, the temperature of the product rises to a level in the range of 42-95ºC (Pruthi and Mishra, 1963), which varies with the oil and moisture content of the spices, but spices lose a significant fraction of their volatile oil or flavoring components due to this temperature rise.

The losses of volatile oil for different spices have been reported to be in the range of 37 per cent for nutmeg, 14 per cent for mace, 17 per cent for cinnamon and 17per cent for oregano (Andres, 1976). The loss of volatile oil during grinding of caraway seed has been reported to be 32% less at the temperature of 45ºC than that of -17ºC (Wolf and Pahl, 1990).

The loss of volatile oil can be significantly reduced by cryogenic grinding technique (Pruthi, 1987). Liquid nitrogen at -195.6ºC provides the refrigeration needed to pre-cool the spices and maintain the desired low temperature by absorbing the heat generated during the grinding operation. In addition to maintaining the low temperature, vapourization of the liquid nitrogen to a gaseous state, creates an inert and dry atmosphere for additional protection of spice quality. Continuous low temperature maintained within the mill reduces the loss of volatile oils and moisture thereby retaining most of the flavour strength per unit mass of spice**.**

Extremely low temperature in the grinder, solidifies oils so that the spices become embrittled; so that they crumble and easily permitting finer grinding and more consistent particle size. With cryogenic grinding, the temperature of the products can be as low as -195.6ºC. But such a low temperature is not required for all the spices. In practice, it is regulated anywhere from -195.6ºC to a few degrees below ambient temperatures (Russo, 1976).

6. **Critical review of present status of the technology at national and international levels along with complete references** :

Pruthi and Mishra (1963) reported that during grinding, the temperature of a product rises to a level in the range of 42-95ºC which varies with the oil and moisture content of the spices. The spices lose a significant fraction of their volatile oil or flavoring components due to temperature rise.

Singh and Goswami (1997) reported that the temperature raises to the range of 42-93ºC in spice grinding causes a loss of volatile oil and flavoring constituents for materials with high oil content, oil comes out during grinding, which makes the ground product gummy, sticky and results in chocking of sieves through which the product passes.

Malkin and Guo (2007) suggested that a better product could be obtained by reducing the temperature of the two rubbing surfaces. The temperature rise of the product can be minimized to some extent by circulating cold air or water around the grinder. But this technique is not sufficient enough to significantly reduce the temperature rise of the product. The extremely low temperature in the grinder solidifies the oil, therefore that the spices become brittle; they crumble easily permitting grinding to a finer and more consistent size.

Cryogenic grinding of fenugreek resulted in retention of 60% more total oil, 28% more Total Phenolic Content, 60% more Total Flavanoid Content and 180% more antioxidant activity of ground powder than normal grinding. (Saxena et al., 2016)

Cryogenic grinding technology is able to retain flavour and medicinal properties of coriander and fenugreek irrespective of the genotype and can be used to recover higher amount of diosgenin from fenugreek for commercial use. (Saxena et al., 2013)

Cryogenic grinding resulted in fine particle size than ambient grinding. Energy requirement was less in cryogenic grinding. Energy requirement did not vary with moisture in cryogenic grinding. Energy constant - Rittinger and Kick's constant - decreased diminutively with increasing moisture content at cryogenic grinding. Number of particles per gram more in cryogenic grinding. Color index, i.e., BI, was superior in cryogenic grinding. (Barnwal et al., 2014)

Shanmugasundaram (2018) reported that low temperature grinding provided superior quality product compared to the ambient temperature grinding, and is more economical than cryogenic grinding.

References :

1. Andres C. 1976. Grinding spices at cryogenic temperatures retains volatiles and oils, *Food Proc*., 37(9):52-53.
2. B. Manohar and B.S. Sridhar. 2001. Size and shape characterization of conventionally and cryogenically ground turmeric (*Curcuma domestica*) particles, *Pow.Tech.*, 120:292–297.
3. P. Barnwal1, A. Mohite, K.K. Singh, P. Kumar, T.J. Zachariahand and S.N. Saxena. 2014. Effect of cryogenic and ambient grinding on grinding characteristics of cinnamon and turmeric, *Int. J. Seed Spi.*, 4(2):26-31.
4. Singh, K.K., and Goswami, T.K. 2000. Thermal properties of cumin seed. J. Food Engg. 45:181–187.
5. Singh, K.K., and Goswami, T.K.1999. Design of a Cryogenic Grinding System for Spices. Journal of Food Engineering. 39(10): 359-368.
6. Take Ajaykumar M., JadhavSandeep L. and Bhotmange Madhukar G. 2012. Effect of Pretreatments on Quality Attributes of Dried Green Chilli Powder, ISCA J. of Eng. Sci., 1(1):71-74.
7. Wolf T. and Pahl M.H. 1990. Cold grinding of caraway seeds in impact mill, Int. J. of Tech. and Food Pro. Eng., 41(10):596-604.
8. Saxena S N, P. Saxena, S. S. Rathore, L. K. Sharma, R. Saxena, P. Barnwal. 2016. Effect of cryogenic grinding on phenolic compounds and antioxidant properties of fenugreek seed extract. J. of Spices and Aromatic Crops. 25(1):73-78.
9. Saxena R, S. S. Rathore, P. Barnwal, Aditi Soni, Lokesh Sharma and S. N Saxena. 2013. Effet of cryogenic grinding on recovery of diosgenin content fengreek genotypes. International J. Seed Spices 3(1):26-30.
10. P. Barnwal, K.K. Singh, A. Mohite, A. Sharma and S.N. Saxena. 2015. Influence of cryogenic and ambient grinding on grinding characteristics of fenugreek powder: A comparative study. J. of Food Processing and Preservation.39:1243-1250.
11. Shanmugasundaram, Abinaya Sekar, AakashVarsha Swaminathan, Abisheka Pandian, ArunMouli. 2018. Low temperature grinding of turmeric. AgricEngInt: CIGR Journal Open access. 20(3):215-220.

7. Expertise available with the investigating group/Institute

The PI & Co-PI of project is having enough experience of working in the field of Processing and Food Engineering. Both are the experts in the field of Processing and Food Engineering. The PI is quite capable and qualified to handle this project. The facility and man power is available in the institute for fabrication of the machine and to conduct the operations in the laboratory. Co-PIs from Biotechnology Department of Junagadh Agricultural University are handling laboratory for GC-MS, HPLC, TLC etc. hence, biochemical and volatile compound analysis will become possible.

8. Brief note on Proprietary/Patent Perspective (for projects related to technology development)/Ethics/Animal Welfare/Bio Safety Issues

- No issues are there on these aspects.

9. (a) **Expected output**

i. The existing spice grinding process will be modified in low temperature grinding. It will be more efficient in comparison to conventional process.
ii. The proposed technology will be economical and can be affordable by the small processors also.
iii. There will be reduction in the processing cost.

a. Clientele/Stake holders (including economic and socio aspects)

i. Food scientists
ii. Spice grinders
iii. Grinder manufacturers.
iv. Consumers

10. **Signatures**

[Project Leader] [Co-PIs] ……

11. **Comments and signature**

[Head of Division]

ANNEXURE- II

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

RESEARCH PROJECT PROFORMA FOR INITIATION OF A RESEARCH PROJECT (RPP - I)

(Refer for Guidelines ANNEXURE-XI (B))

1. Institute Project Code (to be provided by PME Cell)

2. Project Title : Low temperature grinding of spices.

3. Key Words : Grinding, spices, low temperature

4. **(a) Name of the Lead Institute** : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

(b) Name of Division/ Regional Center/ Section : AICRP on PHET, Junagadh centre

5. **(a) Name of the Collaborating Institute(s)** : --

   (b) Name of Division/ Regional Center/ Section of Collaborating Institute(s) : Department of Biotechnology, JAU, Junagadh.

6. **Project Team(Name(s) and designation of PI, CC-PI and all project Co-PIs, with time proposed to be spent)**

S. No.	Name, designation and institute	Status in the project (PI/CC-PI/ Co-PI)	Time to be spent (%)	Work components to be assigned to individual scientist
1.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	1. Development of low temperature grinder 2. Grinding of spices 3. Modifications in the low temperature grinder 4. Data collection and its analysis 5. Report writing
2.	Dr. P. R. Davara, Assistant Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	10%	To assist the PI in all above aspects
3	Dr. H. P. Gajera Associate Research Scientist Department of Biotechnology College of Agriculture, Junagadh Agril. University, Junagadh	Co-PI	20%	1. Assessment of biochemical and volatile compound in spiced powder. 2. Data collection and report writing of biochemical and volatile compound available in spice powder through laboratory analysis.
4	Dr. Khyati J. Jadav Jr. Scientist Department of Biotechnology College of Agriculture, Junagadh Agril. University, Junagadh	Co-PI	10%	To assist in laboratory analysis.

7. **Priority Area to which the project belongs** : Post Harvest Technology
   (If not already in the priority area, give justification)

8. Project Duration: Date of Start: 01-03-2018
LikelyDate of Completion **:** 31-03-2020

9. (a) Objectives

i. Development of low temperature grinding machine
ii. Grinding of spices (Chilly, Turmeric) at low temperature
iii. Assessment of biochemical and volatile compound of spice powder.

(b) Practical utility

i. Cryogenic grinding is present technology to preserve biochemical and volatile compound in spice powder which is costly for general purpose. This technology will be cost economic for grinding of spice powder with preserving biochemical and volatile compound.
ii. The proposed technology will be economical and can be affordable by the small processors also.

10. Activities and outputs details

Objective wise	Activity	Month & Year of		Output monitorable target(s)	% to be carried out in different years			Scientist(s) responsible
		Start	Completion		1	2	..	
1.	1. Review collection	March-18	April-18	To collect the data on existing spice grinding process prevailing	100 %	--	--	Dr. M. N. Dabhi
	2. Designing of low temperature grinder	May-1	July-18	Conceptual design of low temperature spice grinder will be prepared	100 %	--	--	Dr. M. N. Dabhi,
	3. Development of low temperature grinder	Aug-18	Mar-19	Low temperature spice grinder will be developed as per the design prepared	50%	50%	--	Dr. M. N. Dabhi Dr. P. R. Davara,
2.	Grinding of spices	April-19	June-19	Grinding of chilly and turmeric will be carried out and temperature profile will be prepared	50%	50%	--	Dr. M. N. Dabhi Dr. P. R. Davara,
3.	Analysis of biochemica	July-19	Sept-19	Biochemical analysis will	50%	50%	--	Dr. H. P. Gajera

	l and volatile compound			be carried out using appropriate technology of chromatography				Dr. Khyati J. Jadav
4.	Cost economics of low temperature grinding	Oct-19	Dec-19	Cost economics of the low temperature grinding at the standardized process parameters will be derived	--	100 %	--	Dr. M. N. Dabhi Dr. P. R. Davara,
5.	Report writing	Jan-20	Marh-20	Compilation of collected data and preparation of report	--	100 %	--	Dr. M. N. Dabhi

Work Plan/Activity Chart

2018										2019													2020		
Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Review collection																								
		Designing of low temperature grinder																						
					Development of low temperature grinder																				
													Grinding of spices											
																Analysis of biochemical and volatile compound								
																			Cost economics of low temperatu					

																		re grinding				
																					Report writing	

11. Technical Programme (brief)

Justification :

Spice is converted to powder by the mechanical process of grinding which leads to increase the temperature as high as 43-95°C under ambient or normal conditions which leads to losses of essential oils and quality deterioration of the obtained powder (Singh and Goswami, 1999, 2000). Chilli is known for its acidic flavor (pungency) and color. Pungency of chilli is the function of alkaloid capsaicin while color is due to presence of capsanthin pigments (mainly carotenoids) (Take *et. al.*, 2012). In India currently many milling methods are used among those chilli pounding machine, spice pulverizer, low temperature pulverizer are popular methods. During grinding process lot of heat generated in the grinding chamber shoots 45 ^{o}C up to 90 ^{o}C due to friction (Manohar, 2001; Barnwal, 2012). However, etheric oil, volatile components and heat-sensitive constituents of spices boils off at temperature about 50 – 60 ^{o}C, results in reducing of inferior qualities aroma and taste of the ground product (Wolf and Pahl, 1990; Singh and Goswami, 1999). For better quality retention of chilly is obtained by grinding process at lower operating temperatures. Cryogenic grinding is a unique and advanced technique of grinding process which supports in retaining virtuous flavour, colour, aroma and volatile oil of the ground product (Andres, 1976). In cryogenic grinding technique liquid nitrogen is used to control grinding chamber temperature ranging from 0 to -21 °C. Important volatile compound of spices are not available after grinding because of higher temperature during grinding. This may cause of no use of ground spices for special purpose. Cryogenic grinding is costly and requires to lower the temperature upto -190 °C. If grinding temperature can be reduced to the vapourising temperature of volatile compound of spices than it could be restored in ground powder of spices.

Objectives

1. Development of low temperature grinding machine
2. Grinding of spices (Chilly, Turmeric) at low temperature
3. Assessment of biochemical and volatile compound of spice powder.

Technical programme

1. Development of refrigeration system for lowering the temperature surrounding the grinding case.
2. Grinding of spices (Chilly, Turmeric) starting from 0 and 10 degree temperature.
3. Assessment of biochemical compound and volatile compound of spice powder through GC-MS.

Possible outputs :

- The process technology for preserving biochemical compound of spice in the powder will be available at economical cost.

References :

1. Andres C. 1976. Grinding spices at cryogenic temperatures retains volatiles and oils, *Food Proc*., 37(9):52-53.
2. B. Manohar and B.S. Sridhar. 2001. Size and shape characterization of conventionally and cryogenically ground turmeric (*Curcuma domestica*) particles, *Pow.Tech.*, 120:292–297.
3. P. Barnwal1, A. Mohite, K.K. Singh, P. Kumar, T.J. Zachariahand and S.N. Saxena. 2014. Effect of cryogenic and ambient grinding on grinding characteristics of cinnamon and turmeric, *Int. J. Seed Spi.*, 4(2):26-31.
4. Singh, K.K., and Goswami, T.K. 2000. Thermal properties of cumin seed. J. Food Engg. 45:181–187.
5. Singh, K.K., and Goswami, T.K.1999. Design of a Cryogenic Grinding System for Spices. Journal of Food Engineering. 39(10): 359-368.
6. Take Ajaykumar M., JadhavSandeep L. and Bhotmange Madhukar G. 2012. Effect of Pretreatments on Quality Attributes of Dried Green Chilli Powder, ISCA J. of Eng. Sci., 1(1):71-74.
7. Wolf T. and Pahl M.H. 1990. Cold grinding of caraway seeds in impact mill, Int. J. of Tech. and Food Pro. Eng., 41(10):596-604.

12. Financial Implications (` in Lakhs) : Rs. 32.92 lakhs

(A) Financed by the institute

12.1 **Manpower (Salaries / Wages)**

S. No.	Staff Category	Man months	Cost
1.	Scientific	23	30,00,000
2.	Technical	5	2,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	32,00,000

12.2 **Research/Recurring Contingency**

S. No.	Item	Year(1)	Year (2)	Year (3)	Total

1.	Consumables	10000	10000	--	20000
2.	Travel	5000	--	--	5000
3.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--	--
4.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--	--
5.	Animal/Green house/Computer Systems/Machinery Maintenance	2000	--	--	2000
6.	Miscellaneous(Other costs)	5000	--	--	5000
	Total(Recurring)	22000	10000	--	32000

Justification : ----------

12.3 **Non-recurring (Equipment)**

S. No.	Item	Year (1)	Year (2)	Year (3)…	Total
1.	Spice grinder	100000	-	--	100000
	Total (Non-recurring)	100000	--	--	100000

Justification : ----------

12.4 **Any Other Special Facility required (including cost)**

12.5 **Grand Total (12.1 to 12.4)**

Item	Year (1)	Year (2)	Year (3)	Total
Grand Total	17,22,000	16,10,000	--	33,32,000

(B) **Financed by an organization other than the Institute (if applicable)** : No

(i) Name of Financing Organization : NA

(ii) Total Budget of the Project : --

(iii) Budget details

S. No.	**Item**	**Year(1)**	**Year(2)**	**Year (3)**	**Total**
1	Recurring Contingency				
	Travelling Allowance	--	--	--	--
	Workshops	--	--	--	--
	Contractual Services/ Salaries	--	--	--	--
	Operational Cost	--	--	--	--
	Consumables	--	--	--	--
2	Non - Recurring Contingency				
	Equipment	--	--	--	--
	Furniture	--	--	--	--

	Vehicle	--	--	--	--
	Others (Miscellaneous)	--	--	--	--
3	HRD Component				
	Training	--	--	--	--
	Consultancy	--	--	--	--
4	Works (i) New (ii) Renovation	--	--	--	--
5	Institutional Charges				

7. Expected Output : New technology for low temperature grinding will be available.

8. Expected Benefits and Economic Impact

- High cost technology of cryogenic grinding can be replaced by low temperature grinding.
- Cost economic of spice grinding could be available.
- Preservation of biochemical and volatile compound could be possible without cryogenic grinding.

9. Risk Analysis

10. Signature

Project Leader Co-PI-I Co-PI-II

11. Signature of HoD

12. Signature of JD (R)/ Director

ANNEXURE - III

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

CHECKLIST FOR SUBMISSION OF RPP-I

(Refer for Guidelines ANNEXURE-XI(C))

1. **Project Title** : Low temperature grinding of spices.
2. **Date of Start & Duration** : Date of Start: 01-03-2018

   Likely Date of Completion : 31-03-2020
3. **Institute Project** [√] or Externally Funded [ ]
4. **Estimated Cost of the Project** : 33.32 lakh
5. **Project Presented in the Divisional/Institutional Seminar?** ~~Yes~~ / No
6. **Have suggested modifications incorporated?** ~~Yes~~ / No
7. **Status Report enclosed** Yes / ~~No~~
8. **Details of work load of investigators in approved ongoing projects**:

Project Leader				Co-PI – I				Co-PI – II…
Proj. Code.	% Time spent	Date of start	Date of compl-etion	Proj. Code.	% Time spent	Date of start	Date of completion	……
PH/JU/17/1	80	March – 2017	Ongoing	PH/JU/17/1	20	March – 2017	Ongoing	

9. **Work Plan/Activity Chart enclosed** Yes / ~~No~~
10. **Included in Institute Plan Activity** Yes / ~~No~~
11. **Any previous Institute/Adhoc/Foreign aided projects on similar lines?** ~~Yes~~ / No
12. **New equipment required for the project** Yes / ~~No~~
13. **Funds available for new equipment** ~~Yes~~ / No
14. **Signatures**

Project Leader Co-PI-I Co-PI-II Co-PI–n

HOD/PD/I/c

ANNEXURE - IV

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

APPRAISAL BY THE PMECELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. **Institute Name**
2. **Project Title**
3. **On scale 1-10 give score to (a) to (j)**

(a)	Relevance of research questions	☐
(b)	Addressing priority of the institute and/or National priority	☐
(c)	New innovativeness expected in the study	☐
(d)	Appropriateness of design/techniques for the questions to be answered	☐
(e)	Elements of bias addressed in the study	☐
(f)	Adequacy of scientist(s) time allocation	☐
(g)	Extent of system review and meta analysis	☐
(h)	Effective control to experiments	☐
(i)	Economic evaluation and cost efficiency analysis	☐
(j)	How appropriately the expected output answers the questions being addressed in the specific subject matter/area (Basic/Applied/Translational/Others)?	☐
	***Total Score out of 100**	

* The score obtained is suggestive of the overall quality ranking of the project

4. **Was there any other project carried in the past in the same area/topic?**

Yes ☐ No ☐

If yes, list the project numbers.

5. **Signature of PME Cell Incharge**

BRIEF REPORT ON ICAR- FCI PROJECT

1. Scheme code No :

2. Title of the Investigation: Study on Determining Storage Losses of Food Grains in FCI and CWC Warehouses and to Recommend Norms for Storage Losses in Efficient Warehouse Management.

3. Name of Investigator : (1) Prof. R. D. Dhudashia
(2) Dr. M.N.Dabhi
(3) Prof. D. M. Vyas

4. Objectives

1. To identify the extent of losses commodity wise i.e. separately wheat and rice.
2. To identify the factors responsible for losses in storage.
3. To arrive at storage loss norms in different agro-climatic regions/state with respect to various factors.
4. To suggest ways and means to reduce the extent of storage losses in different unit operations.

5. Justification

This work aims to identify Study on Determining Storage Losses of Food Grains in FCI and CWC Warehouses and to Recommend Norms for Storage Losses in Efficient Warehouse Management. The works were conducted by 20 AICRP on PHT Centers throughout the country nominated by the Project Coordinator, AICRP on PHT, Ludhiana.

6. **Date of start:** September-2013

7. Date of completion: September-2017

8.Past work done:

Field investigator and senior research fellow were regularly visited FSD Ghanteshwar-Rajkot, CWC-Bhavnagar and FSD Sabarmati-Ahmedabad and they were recorded observations as per datasheet prepared by PC office. Two stacks in warehouse were liquidated on each quarter. Total 24 stacks of rice were liquidated at FSD Ghanteshwer-Rajkot, and total 24 stacks of wheat were liquidated at CWC-Bhavnagar. Total 24 stacks of wheat and 24 stacks of rice were liquidated at FSD Sabarmati.Thus, liquidation of all stacks were completed on three depot.Data entry in software is under progress.

9. Progress under the project:

Progress of work:

1. Senior research fellow and field investigators had been regularly Visited FSD Ghanteshwar-Rajkot, CWC-Bhavnagar and FSD Sabarmati-Ahmedabad and they recorded observations as per datasheet prepared by PC office.
2. Sixty fortnightly as well as twelfth quarterly observations of rice in warehouse were recorded as per datasheet prepared by PC office. Two stack of rice in warehouse was liquidated on each quarter. Total 24 stacks were liquidated at FSD Ghanteshwer-Rajkot

3. Sixty fortnightly as well as twelfth quarterly observations of wheat in warehouse were recorded as per datasheet prepared by PC office. Two stack of wheat in warehouse was liquidated on each quarter. Total 24stacks were liquidated at CWC-Bhavnagar
4. Sixty fortnightly and twelfth quarterly observations of wheat in warehouse were recorded as per datasheet prepared. Two stack of wheat from warehouse was liquidated on each quarter. Total 24 stacks were liquidated at FSD Sabarmati.
5. Sixty fortnightly and twelfth quarterly observations of Rice in warehouse were recorded at FSD Sabarmati. Two stack of rice from warehouse was liquidated on each quarter. Total 24 stacks were liquidated at FSD Sabarmati.
6. Liquidation of Eight stacks in CAP were completed in February,2015

Table No.1 Stack detail in different warehouse/CAP

State	**District selected**	**Storage Type (Warehouse / CAP)**	**Grains to be studied**	**Selected Godown No.**	**No. of stack prepared**	**No. of liquidated stack**
Gujarat	FSD Sabarmati	Warehouse	Wheat	16Aand 16B	24	24
	FSD Sabarmati	Warehouse	Rice	15A,15B&15 C	24	24
	FSD Sabarmati	CAP	Wheat	PlinthNo.5&8	8	8
	CWC Bhavnagar	Warehouse	Wheat	II and IA	24	24
	FSD Ghanteshwar Rajkot	Warehouse	Rice	1A and 1B	24	24

Observation data as per the format given by PC office is filled regularly and submitted filled to them for further analysis. Data entry in software is under progress.

PUBLICATION, TRAINING AND DEMONSTRATION

Publications:

Books/Book chapter/Bulletin:

1. **Davara, P. R.**, Bhanvadiya, R. R. and Sirwani, P. M. 2018. Development of Extruded Snack Product Incorporating Carrot Paste. Sholar's press, Mauritius.
2. **S.P.Cholera, M.N. Dabhi, P. R. Davara** "Success Stories on Mango Processing Plant". Published on January – 2018.
3. **M. N. Dabhi.** "*Dungali ane Lasani Adhunik Sangrah Paddhatio*" Modern Storage systems for onion and garlic. Chapter in Book "*Masala Pako"* Spice crops. Edited by M. V. Patel, H. K. Patel and J. N. Patel. Published by Anand Agricultural University, Anand. Ext-5:23:2018:2000. 2018. pp.84-89.
4. **M. N. Dabhi**, V. P. Sangani, **P. J. Rathod**. "Enzymatic Pre-treatment in the Processing of Pigeon Pea". December 2018.
5. **M. N. Dabhi**, V. P. Sangani, **P. J. Rathod**. "Tuver dal banavava mate enzyme no upyog"(Use of enzyme for tur dal making). December 2018.

Research Articles

1. **Cholera, S. P.; Dabhi, M. N.; Joshi, A. M**.; Sarsavadia, P. N.; **Rathod, P. J. & Dhudesiya, R. D.** Design and Development of on Farm Solar Dryer For Drying of Ground Nut Pods For Longer Storage. "AGRES - An International e. Journal" Volume : 7(1). 80-102. 2018.
2. **Cholera, S. P.;** Chudasama, S. A.; Gelani, K. A. & Sanghani, J. O. Solar Drying of Groundnut Pods: Better Alternative to Traditional Drying Method. "AGRES - An International e. Journal" Volume : 7(1). 39-**53**. 2018.
3. **Mukesh Dabhi**, Velji Sangani, **Pankaj Rathod**. 2018. Dhal recovery from enzyme pretreated pigeon pea cultivar GJP1. AgricEngInt:CIGR Journal. 20(2):216-225.

Abstract Published

1. **M. N. Dabhi**, V. P. Sangani and P. J. Rathod. Enzyme Pre-treatement for Pigeon Pea Milling. Abstract published in Technical Compedium of National Symposium on "Doubling Farmers' Income Through Technology Interventions" organized at Anand Agricultural University, Anand. 8-10 January, 2018. pp. 47.
2. Dharsenda T. L. and **Dabhi M. N.** Different properties of peanut flour cookies: a Review Abstract published in Technical Compedium of National Symposium on "Doubling Farmers' Income through Technology Interventions" organized at Anand Agricultural University, Anand. 8-10 January, 2018. pp. 101.
3. **S. P. Cholera**, M. H. Jethva. Solar drying : A better alternative to prepare low cost high quality sweet potato flour. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No. 68.
4. **Cholera S. P.**; N.C. Patel. Preparation of Sapota Powder by Osmo-freeze Drying. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No. 69.

5. M.H. Jethva, A.D. Mahaske, **S.P. Cholera**, P. J. Rathod. Effect on Nutritional Quality of Sweet Potato Flour by Different pretreatments using fluidized bed dryer. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No. 69.
6. V. M. Sejani **S. P. Cholera**, V. A. Naliyapara. Drum Dried Peanut Powder: A Better Alternative to Dairy Product. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No.70.
7. **S. P. Cholera**, A.D. Mhaske, B.M. Devani. Honey Base Herbal Banana Powder by Osmo-air drying : A Better Alternative to Babby Food. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No.70.
8. V. M. Sejani **S. P. Cholera**, V. A. Naliyapara. Studies on Canning of Bottle Gourd Pulp. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No.133.
9. Neha Hirpara, **S. P. Cholera**, C.C. Vaishali, N. J. Hirpara. Studies on Canning of Green Peas. 52nd Annual Convention of ISAE & National Symposium on "Doubling Farmers' Income Through Technological Intervention. AAU, Anand on 8th to 10th, Jan., 2018. Page No.133.
10. **S.P.Cholera, M.N. Dabhi, A.M.Joshi**, P.N. Sarsavadia, **P.J. Rathod, R.D. Dhudesia.** Solar Dryer for Groundnut Pods Drying. National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, April, 2018, ICAR-DGR, Junagadh. Page No. 89.
11. **S. P. Cholera,** S.A. Chudasma, K.A. Gelani, J.D. Sanghani. Drying Characteristics of Groundnut Pods By Solar Dryer. National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario, April, 2018, ICAR-DGR, Junagadh. . Page No. 90.

Extension Activities

1. Delivered the lecture on "Importance of processing and value addition of agricultural produce" during the farmers training held on 23-08-2018 at Farmers Training Centre, Junagadh.
2. Delivered a radio talk on "Post-Harvest Management and Value addition of Agricultural Produce" on Junagadh Janvani 91.2 FM at Community Radio Station, JAU, Junagadh on 21-09-2018.
3. Dr. P. R. Davara has delivered the lecture on "Post Harvest Management of Horticultural crops" during the training of Class-I & II Horticulture Officers of state department held at Centre of Excellence on Mango, Talala on 23-08-2018.
4. Dr. M. N. Dabhi has delivered the lecture on "Status and scope of agro processing centre in Gujarat" in the National Workshop on "Enahancement of Farmers Income through Post Harvest Management" held at AAU, Anand on 28-08-2018.
5. Dr. S. P. Cholera has delivered the lecture on "Modern onion storage methods" in the training program of Onion Growers jointly organized by DEE, JAU, Junagadh and Deputy Director, Horticulture, Laghu Krushi Bhawan, Junagadh on 16-08-2018 at FTC, Sardarbaugh, Junagadh and delivered a lecture : **'ડુંગળીનો આધુનિક પધ્ધતિઓથી સંગ્રહ'.**

6. Dr. P. R. Davara has Delivered the lecture on “Procedure and regulations for the export of seed spices” during the farmers training held on 29-10-2018 at KVK, JAU, Jamnagar organized by Vegetable Research Station, JAU, Junagadh.
7. Dr. P. R. Davara has Delivered a radio talk on “Post Harvest Management of Oilseed Crops” on Junagadh Janvani 91.2 FM at Community Radio Station, JAU, Junagadh telecasted on 18-10-2018.

Demonstration conducted :

- Cumin cleaner cum grader was demonstrated at Nandana Village of Devbhumi Dwarka District in collaboration with AKRSP(India), Bhatiya office. More than 60 farmers were present in demonstration. They were willing to use this machine for their cumin cleaning and grading.

Demonstration of cumin cleaner cum grader

- Dr. P. R. Davara has delivered the lecture on “Value addition through agril. Processing” during the farmers training held at FTC, Junagadh on 04-07-2018.
- Dr. S. P. Cholera has delivered the lecture on “Processing, value addition and storage management in horticultural crops” during the farmers training held at FTC, Junagadh on 16-07-2018.
- Demonstrated the women farmers about the preparation of extruded product from cereal flours in the Dept. of Processing and Food Engineering on 09-08-2018.


- Dr. S. P. Cholera has acted as SMS and guided Honorable Governor of Karnataka State Shri Vajubhai Vala and his team.Handling and Management of Processing & Food Engineering Department (CAET) Stall in an Extension Exhibition organized by Director of Extension Education on 09.09.2018 at JAU, Junagadh.




- Demonstrated the farmers about the preparation of extruded product from cereal flours in the Dept. of Processing and Food Engineering on 12-09-2018.

- **HUMAN RESOURCE DEVELOPMENT**

1. PHET scientists have attended the AGRESCO meeting of Junagadh Agricultural University during 15-16 February 2019 and presented new projects.
2. **M. N. Dabhi and P. R. Davara** have participated National Symposium on "Doubling Farmers' Income Through Technology Interventions" organized at Anand Agricultural University, Anand. 8-10 January, 2018.
3. **Cholera S. P. Dabhi M. N., Joshi A. M., Rathod P. J. and Dhudesiya R. D.** have participated National Conference on Enhancing Productivity of Oilseeds in Changing Climate Scenario held at Directorate of Groundnut (ICAR), Jundagadh during 7-9 April, 2018.
4. **Dr. M. N. Dabhi and Dr. P. R. Davara** have participated in the National Workshop on "Enahancement of Farmers Income through Post Harvest Management" held at AAU, Anand on 28 August 2018.
5. **Prof. A. M. Joshi** has attended CAFT programme on Soft Computing Tools for Applications in Food & Agricultural Processing held at CIAE Bhopal during August 1-21, 2018.