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AICRP ON POST-HARVEST ENGINEERING AND TECHNOLOGY JUNAGADH CENTRE

ANNUAL REPORT

(2024-2025)

To be presented
at
Assam Agricultural University,
Jorhat – 785013, Assam

During
20-22 November, 2024

AICRP ON POST-HARVEST ENGINEERING AND TECHNOLOGY
COLLEGE OF AGRICULTURAL ENGINEERING & TECHNOLOGY
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH – 362 001 (GUJARAT)

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ANNUAL REPORT
2024 - 2025

ALL INDIA COORDINATED RESEARCH PROJECT (ICAR)

ON

POST-HARVEST ENGINEERING AND TECHNOLOGY

JUNAGADH CENTRE

To be presented
at
Assam Agricultural University, Jorhat (Assam)

During
20-22 November, 2024

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

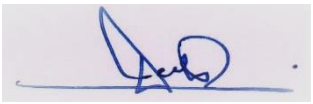
ACKNOWLEDGEMENT

The All India Coordinated Research Project on Post-Harvest Engineering and Technology staff of Junagadh Centre wish to express earnest gratitude and heartfelt thanks to Dr. S. N. Jha, Deputy Director General (Engineering) and Dr. K. Narsaih, Assistant Director General (PE) ICAR, New Delhi. We place with deep sense of gratitude and respect to Dr. R. K. Vishwakarma, Project Coordinator, AICRP on Post-Harvest Engineering and Technology, Central Institute of Post-Harvest Engineering & Technology, Ludhiana for their inspiring guidance, coordination as well as their keen interest in the activities of the scheme.

We acknowledge with thanks to Dr. V. P. Chovatiya, Vice Chancellor Junagadh Agricultural University, Junagadh; for their highly support in the activities of the scheme. We here by express our sincere thanks to Dr. R. B. Madariya, Director of Research, for able monitoring of the scheme work and Sh. S. K. Jethani, Comptroller Junagadh Agricultural University, Junagadh for resolving financial matters speedily. We hereby affirmative our honest thanks to Dr. H. D. Rank, Principal & Dean, College of Agricultural Engineering & Technology, Junagadh for caring direction, thought provoking annotations and keen interest shown in the activities of the scheme.

The staff members of the scheme convey the special thanks for the financial assistance received by ICAR to run the scheme absolutely.

At the last but not the list, we take this opportunity to express our thanks to all the staff members of the Department of Processing and Food Engineering for their support and taking due interest in the activities of the scheme work.



November 05, 2024
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 2024-2025 for which this report is presented** **(Upto 01/11/2024)**	:	**Rs. 88,14,999.75** (ICAR share)

6. Staff position in the scheme

Sr. No.	Category	Post	Name of the Staff	Date of Joining the Scheme
1.	Scientific	Research Engineer	Dr. M. N. Dabhi	01.09.2016
2.		Asstt. Bio-Chemist	Vacant	31.03.2022
3.		Asstt. Entomologist	Prof. D. V. Khanpara	16.06.1922
4.		Asstt. Food Microbiologist	Prof. A.M. Joshi	18.02.2009
5.		Asstt. Res. Engineer (ASPE)	Dr. P. R. Davara	01.01.2011
6.		Asstt. Process Engr. (Testing & Eva.)	Prof. B. M. Devani	01-03-2024
7.	Technical	Senior Tech. Asstt.	Er. H. R. Sojaliya	14.02.2012
8.		Investigator	Er. B. A. Karangiya	08.06.2022
9.		Draftman (Mech.)	Shri R. V. Bokhiriya	01.01.2021
10.		Craftman-I (Welder)	Shri V. S. Kava	01.11.2014
11.		Craftman-II (Fitter)	Shri N. V. Vora	28.12.2008
12.		Craftman-III (Tinsmith)	Vacant	01.07.2016
13.		Senior Mechanic	Shri A. P. Zezariya	26.07.2018

7. Expenditure Statement for the year 2024-2025 (Upto November, 2024)

Statement showing the details of expenditure incurred (ICAR Share-75%) in PHET, Junagadh till Nov-2024

Sr. No.	Head of expenditure	Sanctioned grant for the year 2024-25 Rs.	Total Fund Rs.	Total Expenditure up to Nov., 2024 Rs.	Unspent balance as on Dec. 01, 2024 Rs. (4-6)
1	**2**	**3**	**4**	**6**	**7**
1	Pay and Allowances	81,39,999.00	81,39,999.00	81,07,886.25	32,112.75
2	Travelling Allowance	1,25,000.25	1,25,000.25	13,261.50	1,11,738.75
3	Recurring Contingencies (Including HRD)	5,50,000.50	5,50,000.50	1,95,592.50	3,54,408.00
4	Non recurring contingencies	0.00	0.00	0.00	0.00
	Total	**Rs. 88,14,999.75**	**Rs. 88,14,999.75**	**Rs. 83,16,740.25**	**Rs. 4,98,259.50**

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/2024/01	Development of Protein Enriched Ready-to-Eat Extruded Product ideal for Fasting by Supplementing Defatted Peanut Flour.
3.	PH/JU/2023/1	Management of Insect Pest of Storage Wheat in Bin by Ozone.
4.	New Investigation - I	Protein Extraction from Deoiled Castor Seeds Cake through Microbial Intervention.
5.	New Investigation - II	Development of Jamun Leather using Refractance Window Dryer.
6.	New Investigation - III	Extraction of bioactive compounds from castor leaves to check effect against the *Malassezia* spp.

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. Dr. P. R. Davara

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 2024-25. All the installment of Loej and Virol are deposited and the equipments purchased for them are given for permanent and now there is no due for payments. The equipment from our store register are removed and they have listed in their store register.

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.

PROJECT – 1

Title : Value Chain on groundnut

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/2024/01
2. Investigators as approved in RPP-I, If any change attach IRC proceedings:

Principal Investigator	Co-PIs	
Dr. P. R. Davara	Dr. M. N. Dabhi	Prof. A. M. Joshi

3.	Any change in objectives and activities (If yes, attach IRC proceedings)	No	
4.	Date of Start & Date of Completion (Actual). If any extension granted enclose IRC proceedings	01-03-2024	20-10-2024
5.	Whether all objectives met	Yes	No
6.	All activities completed	Yes	No
7.	Salient achievements/major recommendations included	Yes	No
8.	Annual Progress Reports (RPP-II) submitted	1st Year: Yes	No
		2nd Year: No	No
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:		

P. R. Davara	**M. N. Dabhi**	**Prof. A. M. Joshi**
Principal Investigator	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/2024/01
2. Project Title : Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.
3. Key Words : Defatted peanut flour, amaranth, barnyard millet, tapioca pearl, extrusion cooking, fasting
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
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 spent (%)	Work components 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%	• Review collection/literature survey • Designing of the experiment • Procurement of raw materials • Quality analysis of the raw materials • Experimental trials for the optimization of flour proportion of different ingredient food materials • Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion • Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded product

				• Laboratory trials for the preparation of peanut based extruded product at the optimized flour proportion as per the experimental treatments • Physico-chemical and sensory analysis of the developed extruded products • Data collection and its analysis • Optimization of the processing parameters based on the experimental data • 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	15%	To assist the PI in carrying out the different activities of the project as and when needed
3.	Prof. A. M. Joshi Asst. Microbiologist 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 biochemical analysis of the raw material and developed product

7. Priority Area : Post-Harvest Technology, Food Processing
8. Project Duration : Three years - Date of Start : 01-03-2024
   Date of Completion : 20-10-2024

9. a. Objectives :
    1. To develop extruded product from defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour at different blending ratio.
    2. To optimize the blending ratio of defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour for the preparation of extruded products based on sensory parameters.
    3. To develop extruded product from peanut flour and other fasting food materials under different processing conditions.
    4. To evaluate the physico-chemical, functional and sensory properties of developed extruded products.
    5. To optimize the processing condition for the development of protein enriched extruded product suitable for fasting.

    b. Practical utility :
    1. No any fasting snack product is available in the market. The new peanut based extruded product along with other food materials which is suitable for fasting will be developed.
    2. Protein content in the extruded product will be improved due to blending of peanut flour. Other food materials like amaranth, barnyard millet and tapioca pearl are also very nutritious and suitable for preparation of extruded product. The new process will develop the fasting snack product with more nutritional value in comparison to commercially available extruded products.
    3. The flour proportion of different food materials will be optimized to prepare the fasting snack product with good sensory characteristics.
    4. The process parameters for the preparation of peanut flour based fasting extruded product will be optimized.
    5. The proposed process technology will suggest the proper byproduct utilization of peanut for the preparation of value added product.

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

10.1 Material and methods

- **Technical programme**
- **Optimization of blending ratio of different flours for development of extruded product suitable for fasting**

The different proportions of defatted peanut flour, amaranth flour, barnyard flour and tapioca flour were optimized as per the Mixture Design of Response Surface Methodology (RSM) on the basis of their sensory analysis. The treatment details are given in the Table 2.1. The extruded products were prepared by keeping the feeder temperature (60°C), barrel temperature (100°C), die temperature (135°C) and screw rpm (250 rpm) at constant level. The final and optimized formulation of composite flour was selected for the preparation of extruded product.

Table 2.1. Treatment details for optimization of flour proportion.

Treatment No.	Defatted peanut flour (%)	Amaranth flour (%)	Barnyard flour (%)	Tapioca pearls flour (%)	Total
1	13.53	49.33	14.90	22.24	100.00
2	10.00	39.43	10.00	40.57	100.00
3	29.05	10.00	37.19	23.76	100.00
4	24.56	24.79	25.85	24.81	100.00
5	50.00	10.00	30.00	10.00	100.00
6	10.00	10.00	30.00	50.00	100.00
7	30.00	50.00	10.00	10.00	100.00
8	24.56	24.79	25.85	24.81	100.00
9	39.00	10.00	10.00	41.00	100.00
10	25.37	14.63	50.00	10.00	100.00
11	39.00	10.00	10.00	41.00	100.00
12	25.37	14.63	50.00	10.00	100.00
13	24.56	24.79	25.85	24.81	100.00
14	10.00	10.00	50.00	30.00	100.00
15	35.54	22.65	31.82	10.00	100.00
16	50.00	30.00	10.00	10.00	100.00
17	10.00	28.50	43.34	18.17	100.00
18	24.56	24.79	25.85	24.81	100.00
19	19.45	20.55	10.00	50.00	100.00
20	10.00	47.03	32.97	10.00	100.00

❖ **Raw Material**

Different flours required in the experiment were purchased from local market and their respective suppliers.

	
Defatted peanut flour	Amaranth flour
	
Barnyard flour	Tapioca flour

Plate 2.1. Different flours used in the preparation of extruded product.

❖ **Optimization of processing conditions for development of extruded product suitable for fasting**

Response Surface Methodology (RSM) was used for designing the experiments (Khuri and Cornell, 1987). A Central Composite Rotatable Design (CCRD) with 3 variables each at 5 levels was employed to get the treatment details.

Table 2.2. Coded and uncoded values of independent parameters to be used in the optimization of processing condition for the preparation of extruded product

Parameters	Code	Coded and Uncoded value				
		-1.682	**-1**	**0**	**+1**	**+1.682**
Moisture content (%)	(X_1)	12	13.22	15	16.78	18
Screw speed (rpm)	(X_2)	200	220	250	280	300
Die head temperature (°C)	(X_3)	90	102	120	138	150

Table 2.3. Treatment combinations as per the central composite rotatable design for preparation of extruded product.

Treatment No.	Coded			Uncoded		
	X_1	X_2	X_3	Feed Moisture Content (%)	Screw speed (rpm)	Die head temperature (°C)
1	-1	-1	-1	13.22	220	102
2	1	-1	-1	16.78	220	102
3	-1	1	-1	13.22	280	102
4	1	1	-1	16.78	280	102
5	-1	-1	1	13.22	220	138
6	1	-1	1	16.78	220	138
7	-1	1	1	13.22	280	138
8	1	1	1	16.78	280	138
9	-1.68	0	0	12.00	250	120
10	1.68	0	0	18.00	250	120
11	0	-1.68	0	15.00	200	120
12	0	1.68	0	15.00	300	120
13	0	0	-1.68	15.00	250	90
14	0	0	1.68	15.00	250	150
15	0	0	0	15.00	250	120
16	0	0	0	15.00	250	120
17	0	0	0	15.00	250	120
18	0	0	0	15.00	250	120
19	0	0	0	15.00	250	120
20	0	0	0	15.00	250	120

❖ **Extruded product preparation**

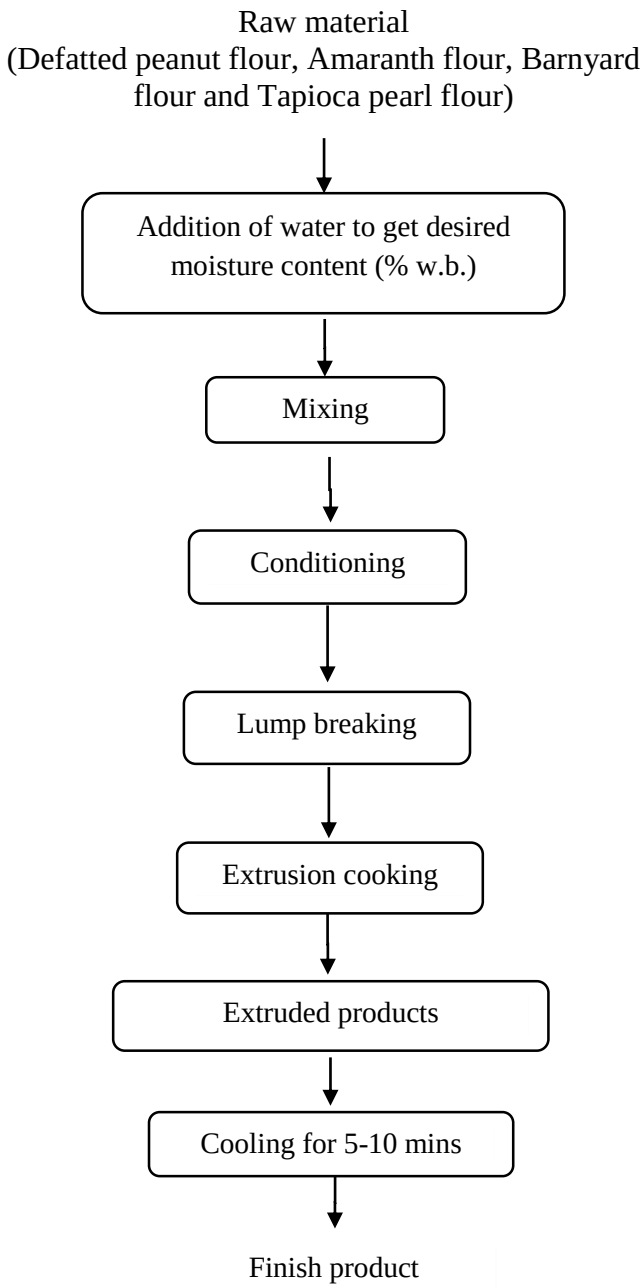


Fig. 2.1. Process flow chart for the preparation of protein enriched extruded product suitable for fasting.

❖ **Laboratory extruder**

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

Plate 2.2. Laboratory twin-screw extruder.

❖ **Dependent parameters :**

Machine parameters

1. Torque requirement
2. Mass flow rate

Physical Parameters of extruded product

1. Bulk density
2. Expansion ratio

Biochemical parameters of extruded product

1. Moisture content
2. Carbohydrate content
3. Protein content

Functional Parameters

1. Water solubility index (WSI)
2. Water absorption index (WAI)
3. Hardness
4. Crispness

Sensory characteristics

1. Appearance
2. Colour
3. Taste
4. Overall acceptability

❖ Results and Discussion

- **Raw material characteristics**

Table 2.4. Biochemical characteristics of different raw materials

Sr No.	Parameters	Defatted peanut flour	Amaranth flour	Barnyard flour	Tapioca flour
1	Moisture content (%)	7.09	8.69	11.15	10.71
2	Carbohydrate (%)	26.49	68.08	71.56	88.97
3	Protein (%)	50.12	13.87	7.81	0.06

❖ Optimization of different flour proportion

Table 2.5. Sensory properties of extruded products prepared for the optimization of flour proportion.

Run	X_1	X_2	X_3	X_4	Feed M. C.	Defatted peanut (%)	Amaranth (%)	Branyard (%)	Tapioca (%)	Appearance	Taste	Colour	Overall acceptability
1	-1	-1	-1	1	16	13.53	49.33	14.90	22.24	6.54	6.58	6.25	6.75
2	0	0	-2	0	16	10.00	39.43	10.00	40.57	7.42	6.54	7.04	7.04
3	0	0	0	-2	16	29.05	10.00	37.19	23.76	5.25	5.33	5.75	5.42
4	-1	1	-1	1	16	24.56	24.79	25.85	24.81	6.08	5.92	6.04	6.25
5	0	0	0	0	16	50.00	10.00	30.00	10.00	4.33	5.33	4.88	4.75
6	-1	-1	-1	-1	16	10.00	10.00	30.00	50.00	7.38	6.58	7.29	7.08
7	0	0	0	2	16	30.00	50.00	10.00	10.00	3.75	4.46	4.13	4.13
8	1	1	-1	1	16	24.56	24.79	25.85	24.81	6.71	6.50	6.54	6.29
9	0	0	0	0	16	39.00	10.00	10.00	41.00	5.08	5.38	4.92	5.04
10	0	-2	0	0	16	25.37	14.63	50.00	10.00	6.83	6.92	6.79	7.17
11	0	0	0	0	16	39.00	10.00	10.00	41.00	4.83	5.21	5.08	4.96
12	0	2	0	0	16	25.37	14.63	50.00	10.00	6.96	7.00	6.96	7.04
13	-2	0	0	0	16	24.56	24.79	25.85	24.81	6.50	6.67	6.58	6.75
14	1	-1	-1	-1	16	10.00	10.00	50.00	30.00	7.83	7.08	7.75	7.58
15	0	0	0	0	16	35.54	22.65	31.82	10.00	4.33	4.79	4.25	4.33
16	0	0	0	0	16	50.00	30.00	10.00	10.00	3.83	3.96	3.67	3.79
17	-1	1	-1	-1	16	10.00	28.50	43.34	18.17	7.13	6.67	7.17	6.83
18	2	0	0	0	16	24.56	24.79	25.85	24.81	6.50	6.21	6.33	6.50
19	1	-1	-1	1	16	19.45	20.55	10.00	50.00	8.33	7.58	8.25	8.33
20	1	1	-1	-1	16	10.00	47.03	32.97	10.00	6.71	6.79	6.50	6.63

❖ **Optimization of processing conditions for preparation of extruded product suitable for fasting**

Plate 2.3. Treatment-wise photographs of different extruded product

Table 2.6. Quality characteristics of extruded product

Std	Run	FM (%)	Screw speed (rpm)	Die temp. (°C)	Mass flow rate (g/min)	Torque (Nm)	BD (g/cm^3)	ER	MC (% w.b)	Carbohydrate (%)	Protein (%)	WSI (%)	WAI (g/g)	Hardness (N)	Crispness	Overall acceptability
1	3	13.22	220.27	102.16	185.45	23	0.0568	3.86	8.82	71.43	16.88	8.63	5.07	189.56	257	6.7
2	20	16.78	220.27	102.16	278.23	19	0.0568	3.91	8.81	74.11	17.21	9.16	4.73	246.32	296	7.5
3	12	13.22	279.73	102.16	231.24	22	0.0544	3.85	8.56	67.22	16.99	7.25	5.55	184.21	288	7.1
4	2	16.78	279.73	102.16	225.68	19	0.0501	3.85	8.95	73.15	17.2	7.50	5.28	221.23	290	7.1
5	13	13.22	220.27	137.84	174.23	22	0.0521	4.15	8.71	63.94	15.86	9.21	4.52	152.32	377	7.5
6	15	16.78	220.27	137.84	226.21	18	0.0539	4.11	8.62	60.38	16.22	8.89	4.34	179.56	326	7.2
7	14	13.22	279.73	137.84	234.18	23	0.0521	4.22	8.65	67.35	16.16	9.22	3.76	161.02	392	7.5
8	18	16.78	279.73	137.84	225.32	18	0.0541	4.03	8.75	67.84	16.5	8.68	3.33	152.32	330	6.9
9	7	12.00	250.00	120.00	201.6	24	0.0549	3.91	8.53	66.56	16.49	8.1	4.51	201.32	339	7.2
10	8	18.00	250.00	120.00	255.32	17	0.0562	3.76	8.83	69.56	17.32	8.50	3.16	222.21	301	7
11	17	15.00	200.00	120.00	210.63	21	0.0553	4.08	8.86	66.14	16.41	8.70	5.18	236.52	298	7.3
12	6	15.00	300.00	120.00	238.44	20	0.0506	4.22	9.02	69.56	16.85	6.20	5.27	185.65	309	7.3
13	4	15.00	250.00	90.00	234.23	20	0.0543	3.78	8.73	74.23	17.22	7.52	5.90	216.32	246	6.9
14	10	15.00	250.00	150.00	195.65	20	0.0505	4.35	8.39	63.52	15.2	10.40	3.99	65.32	366	7.2
15	9	15.00	250.00	120.00	225.65	21	0.0510	4.27	8.79	70.12	16.45	10.32	4.80	136.45	329	7.5
16	5	15.00	250.00	120.00	223.56	21	0.0492	4.26	8.75	69.51	16.53	10.80	5.20	156.38	325	7.3
17	1	15.00	250.00	120.00	230.12	21	0.0513	4.16	8.72	70.12	16.87	9.60	4.41	142.38	321	7.6
18	11	15.00	250.00	120.00	239.88	21	0.0499	4.24	8.82	69.76	16.53	11.20	4.72	130.45	316	7.5
19	16	15.00	250.00	120.00	236.74	20	0.0508	4.19	8.82	69.87	16.52	11.20	5.05	157.14	329	7.7
20	19	15.00	250.00	120.00	239.23	20	0.0499	4.31	8.73	69.21	17.17	10.67	5.25	145.93	339	7.6

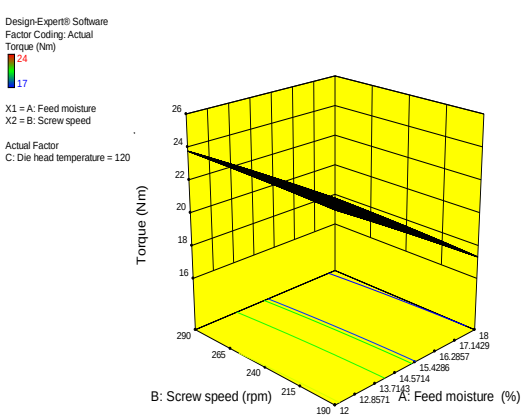
Table 2.7. Analysis of variance table and regression coefficients for response surface quadratic model of different physical and functional characteristics of extruded product

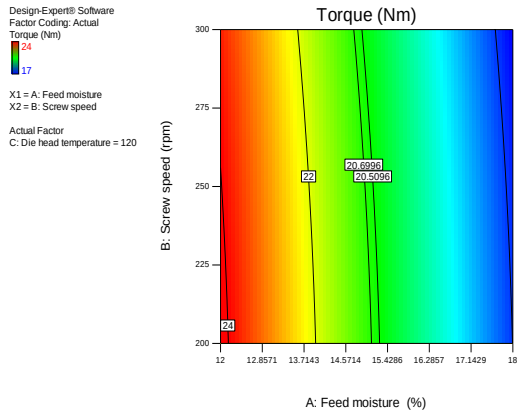
Source	Torque	Mass flow rate	BD	ER	MC	Carbohydrates	Protein	WSI	WAI	Hardness	Crispness	Overall acceptability
Intercept	20.66	232.51	0.05	4.24	8.77	69.76	16.68	10.62	4.91	144.94	326.12	7.53
Linear terms												
$A(X_1)$	-2.03	16.16***	0.00013	-0.032	0.066	0.78***	0.19*	-0.02	-0.26**	10.8	-9.29**	-0.032
$B(X_2)$	-0.12	7.25**	-0.0012***	0.011	0.016	0.84**	0.1	-0.55**	-0.043	-9.58	5.4	-0.022
$C(X_3)$	-0.15	-9.19**	-0.0009**	0.15***	-0.072**	-3.25***	-0.51***	0.61**	-0.58***	-32.95***	35.65***	0.088*
Interaction												
$AB(X_1X_2)$	0.00	-19.9***	-0.00052	-0.025	0.074**	0.91***	-0.017	-0.06	-0.02	-6.96	-4.87	-0.14**
$AC(X_1X_2)$	-0.25	-5.51*	0.001**	-0.035	-0.046	-1.46**	0.02	-0.20	0.00	-9.4	-18.12***	-0.21***
$BC(X_2X_3)$	0.25	8.23**	0.0017**	0.0075**	0.024	2.01***	0.06	0.36	-0.35**	1.49	-1.87	-0.037
Quadratic terms												
$A^2(X_1)^2$	-0.019	-1.33	0.0011***	-0.14***	-0.030	-0.60**	0.091	-0.65**	-0.4***	22.69**	0.17	-0.14**
$B^2(X_2)^2$	-0.019	-2.72	0.00091**	-0.032	0.062**	-0.68***	-0.0061	-1.04***	0.096	22.45**	-7.79*	-0.07
$C^2(X_3)^2$	-0.200	-6.11**	0.00071**	-0.062**	-0.073**	-0.31***	-0.15*	-0.51**	-0.0030	-2.39	-4.78	-0.16***
Indicators for model fitting												
R^2	0.9596	0.9535	0.9394	0.9535	0.901	0.995	0.8996	0.9074	0.9179	0.9287	0.95598	0.8944
Adj-R_2	0.9232	0.9117	0.8848	0.9117	0.813	0.990	0.8093	0.8250	0.8439	0.8646	0.9237	0.8004
Pre-R_2	0.81	0.7676	0.674	0.7789	0.383	0.977	0.7059	0.6178	0.6992	0.5562	0.766	0.5745
Adeq precisi	19.47	21.66	11.84	13.220	12.12	56.62	11.885	9.5380	12.53	15.71	19.14	9.666
F-value	26.37	22.8	17.22	22.81	10.15	212.53	9.96	10.96	12.42	14.48	26.55	9.46
Lack of fit	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	2.42	3.09	1.61	1.39	0.71	1.38	1.38	6.29	6.03	9.12	3.08	1.67

A or X1= Feed moisture content, B or X2 = Screw speed, C or X3 = Die head temperature, *** significant at $p<0.001$, significant at $p < 0.01$, significant $p<0.05$, NS =Non significant

❖ Response surface analysis of depended parameters :

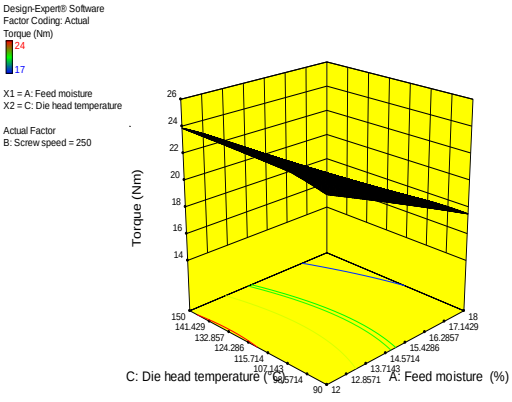
1. Torque

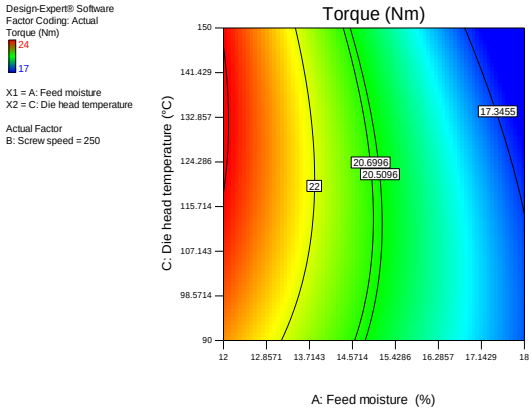




Response surface plot	Contour plot

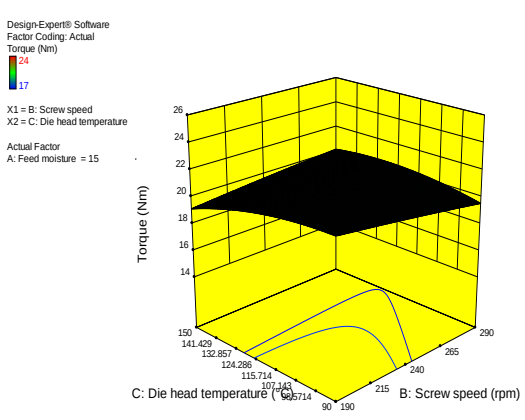
Fig. 2.2. Effect of feed moisture content and screw speed on torque.

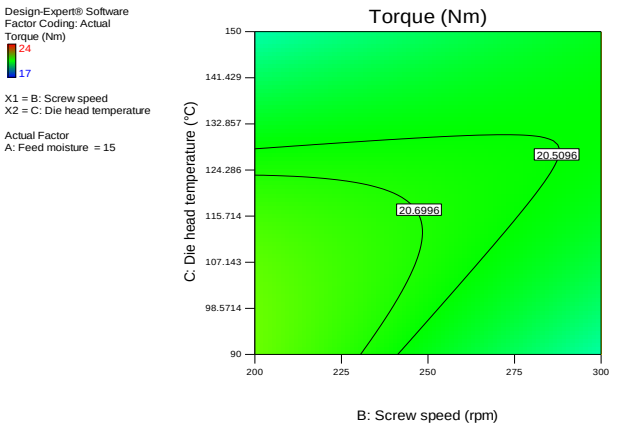




Response surface plot	Contour plot

Fig. 2.3 Effect of feed moisture content and die head temperature on torque.

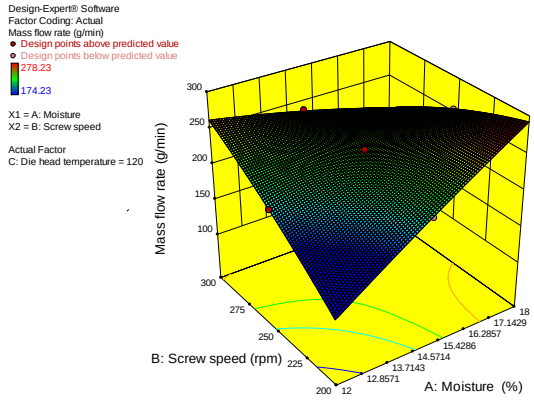


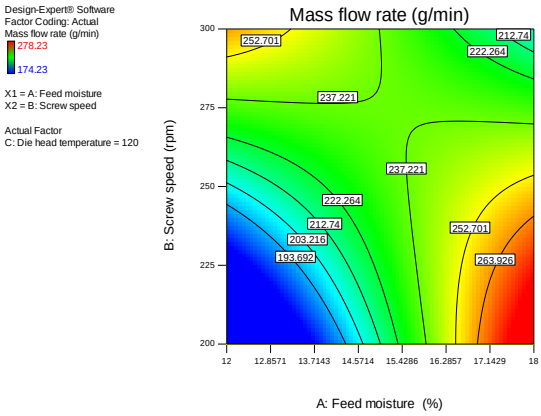


Response surface plot	Contour plot

Fig. 2.4 Effect of screw speed and die head temperature on torque.

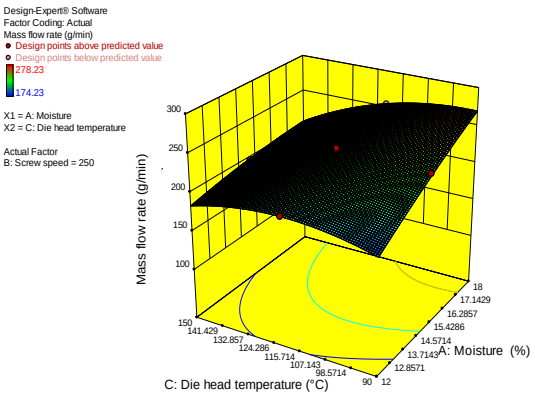
2. Mass flow rate

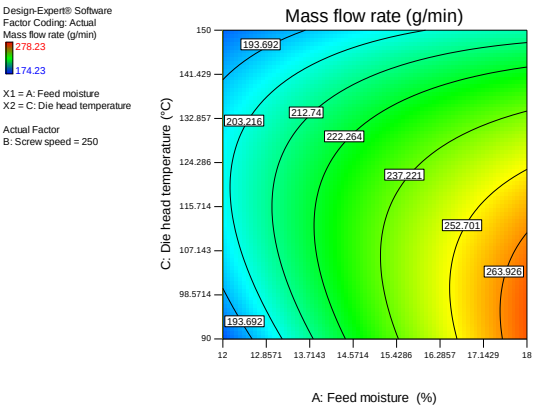




Response surface plot	Contour plot

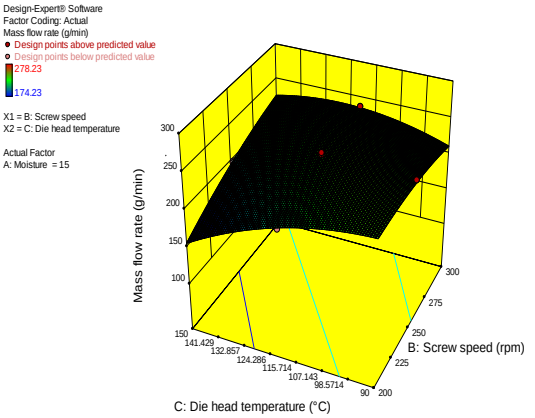
Fig. 2.5 Effect of feed moisture content and screw speed on mass flow rate.

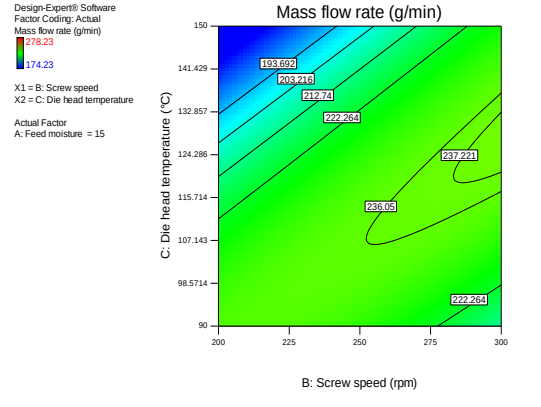




Response surface plot	Contour plot

Fig. 2.6 Effect of feed moisture content and die head temperature on mass flow rate.

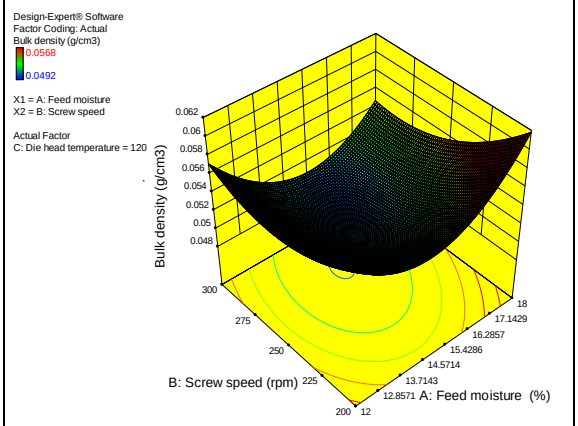


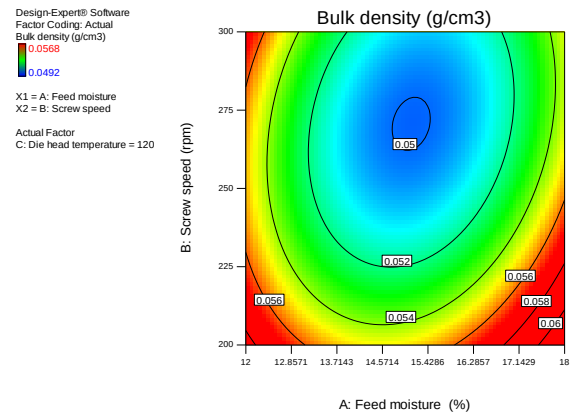


Response surface plot	Contour plot

Fig. 2.7 Effect of screw speed and die head temperature on mass flow rate.

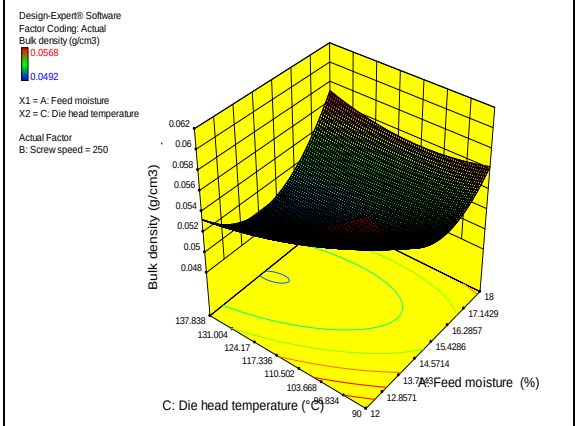
3. Bulk density

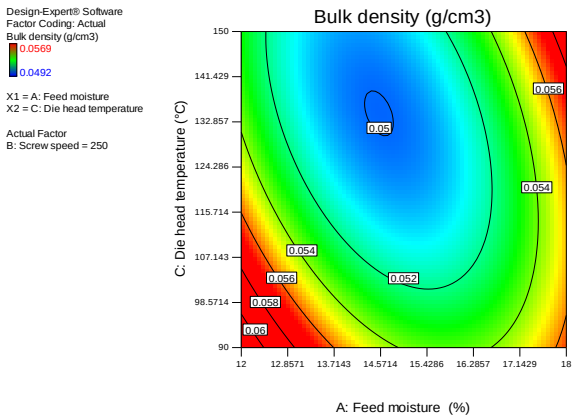




Response surface plot	Contour plot

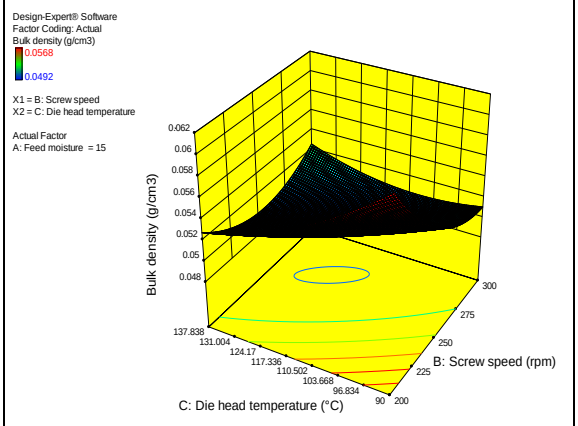
Fig. 2.8 Effect of feed moisture content and screw speed on bulk density.

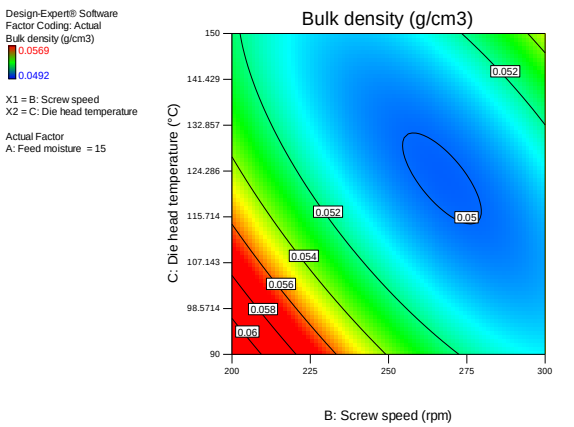




Response surface plot	Contour plot

Fig. 2.9 Effect of feed moisture content and die head temperature on bulk density.

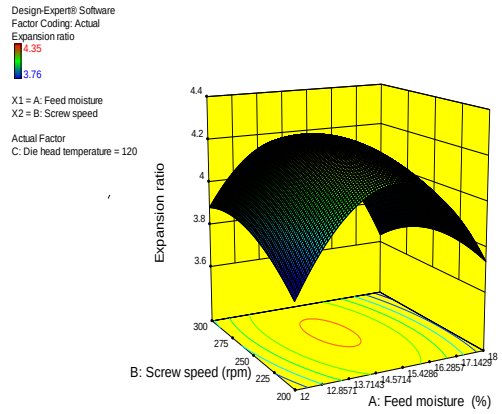


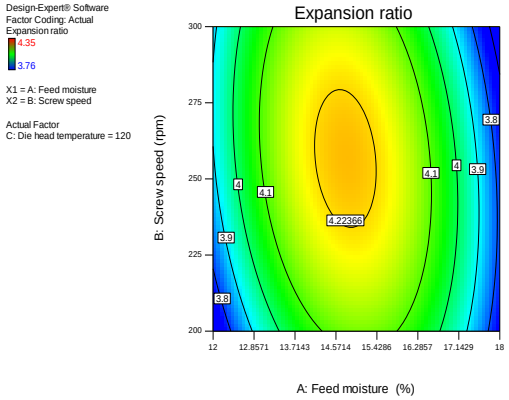


Response surface plot	Contour plot

Fig. 2.10 Effect of die head temp. and screw speed on bulk density.

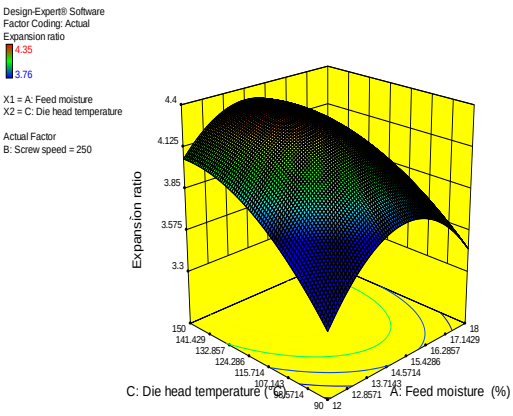
4. Expansion ratio

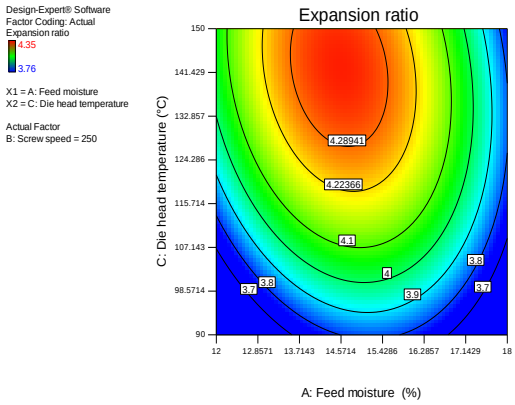




Response surface plot	Contour plot

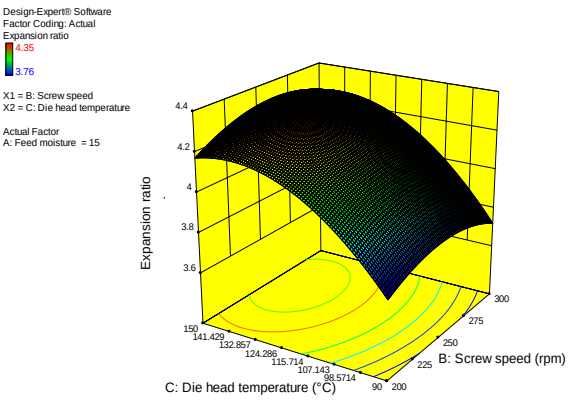
Fig. 2.11 Effect of feed moisture content and screw speed on expansion ratio.

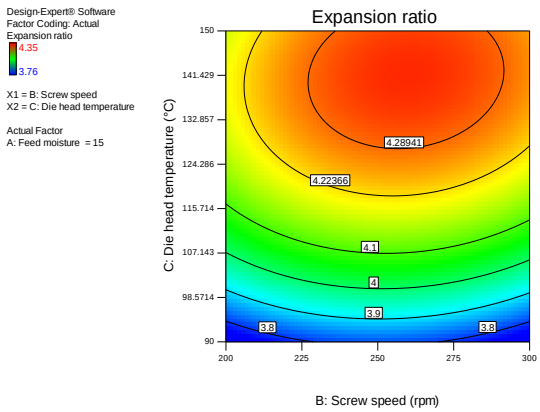




Response surface plot	Contour plot

Fig. 2.12 Effect of feed moisture content and die head temperature on expansion ratio.

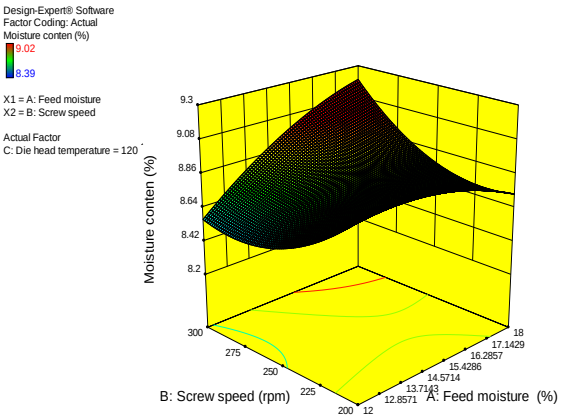


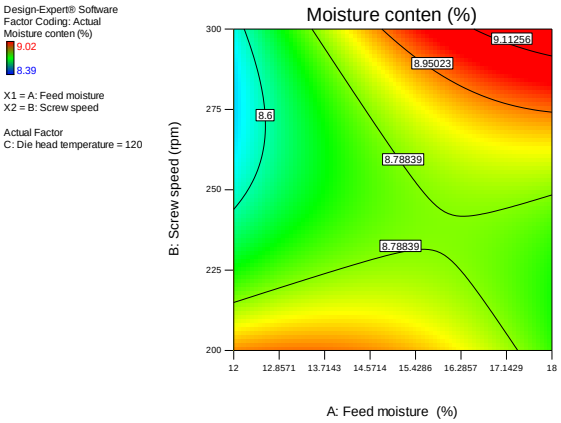


Response surface plot	Contour plot

Fig. 2.13 Effect of die head temp. and screw speed on expansion ratio.

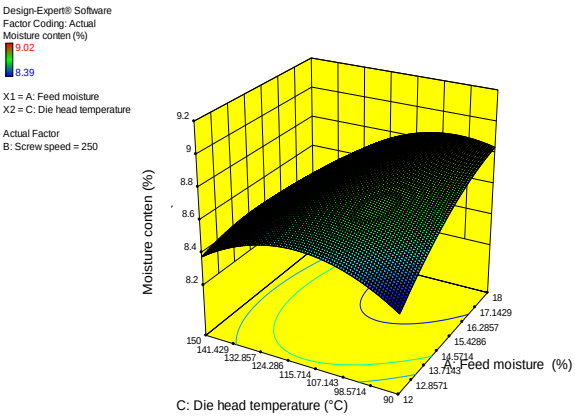
5. Moisture content

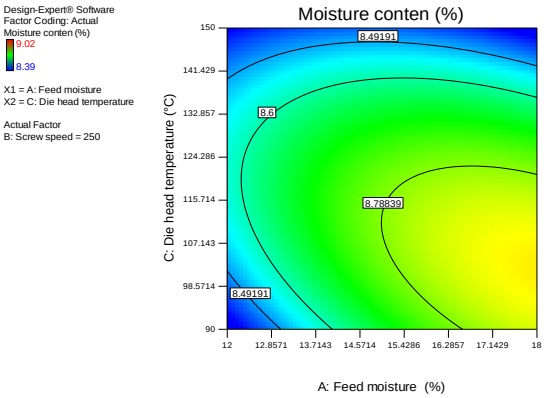




Response surface plot | **Contour plot**

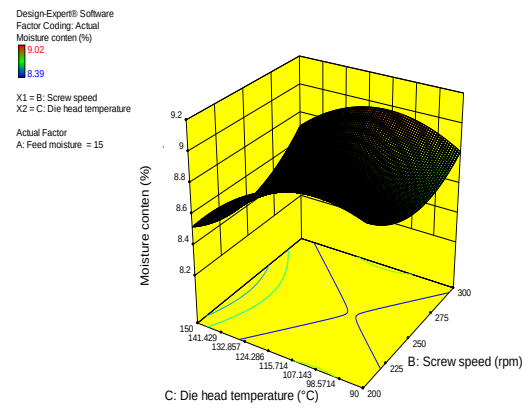
Fig. 2.14 Effect of feed moisture content and screw speed on moisture content.

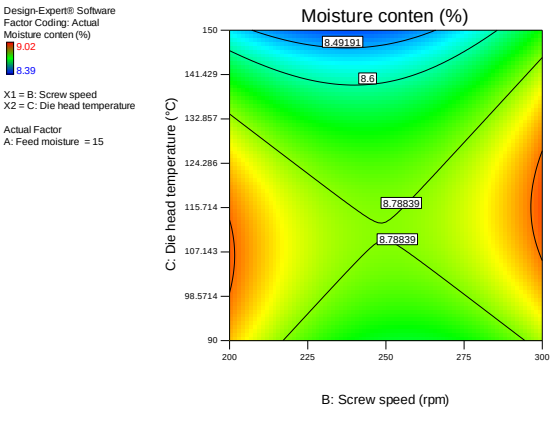




Response surface plot | **Contour plot**

Fig. 2.15 Effect of feed moisture content and die head temperature on moisture content.

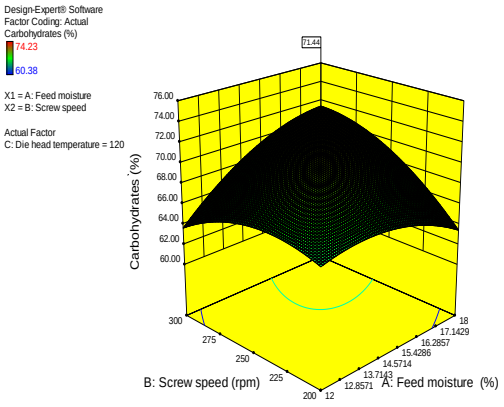


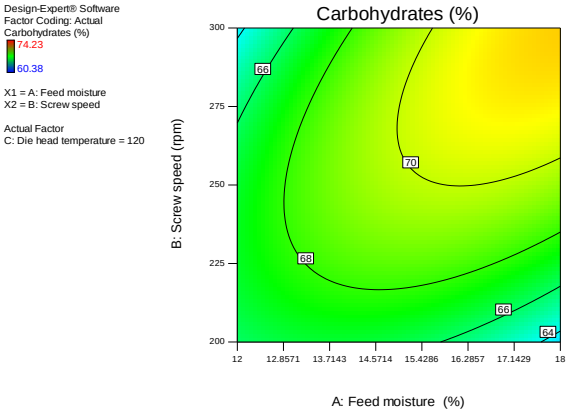


Response surface plot | **Contour plot**

Fig. 2.16 Effect of die head temp. and screw speed on moisture content.

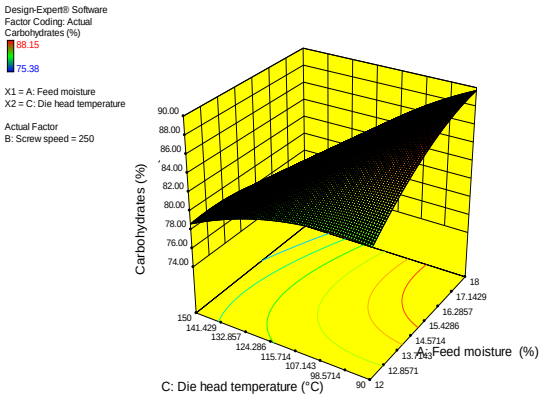
6. Carbohydrate content

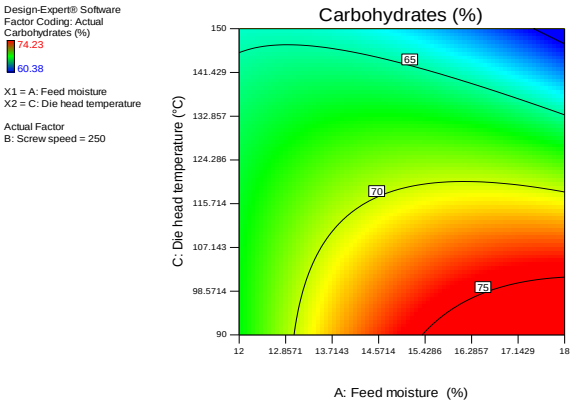




Response surface plot	Contour plot

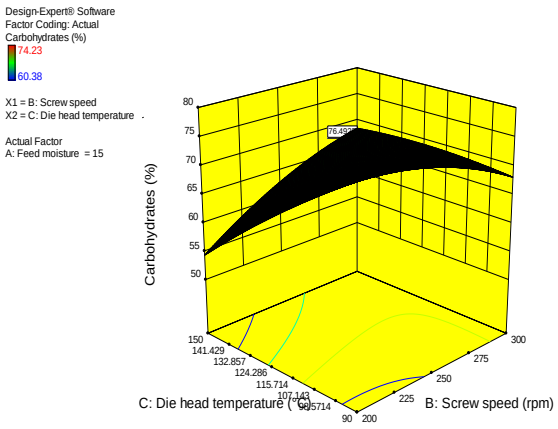
Fig. 2.17 Effect of feed moisture content and screw speed on carbohydrate content.

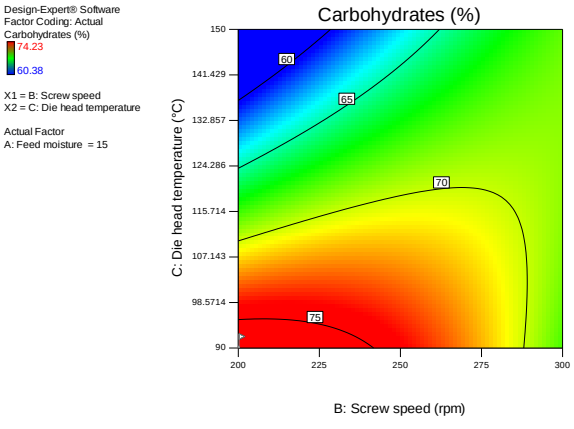




Response surface plot	Contour plot

Fig. 2.18 Effect of feed moisture content and die head temperature on carbohydrate content.

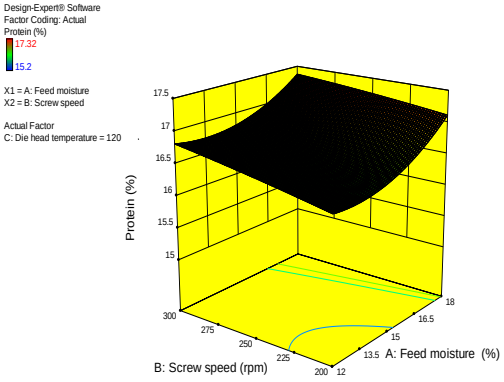


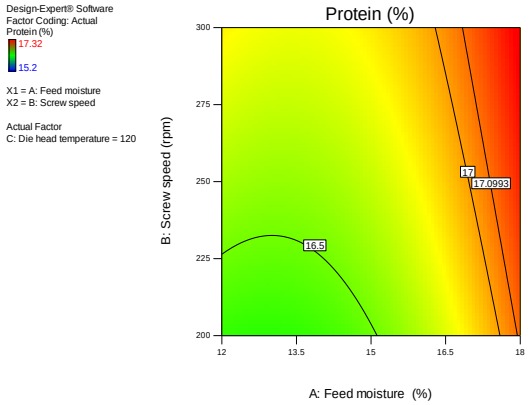


Response surface plot	Contour plot

Fig. 2.19 Effect of die head temp. and screw speed on carbohydrate content.

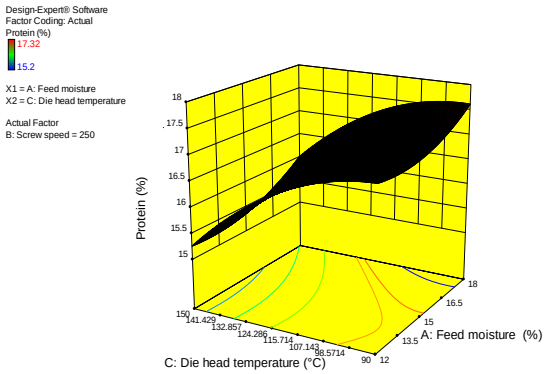
7. Protein content

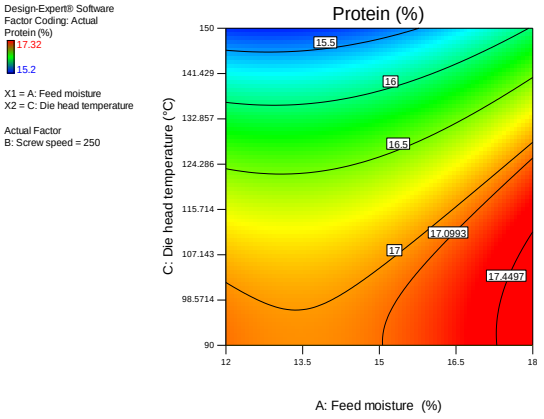




Response surface plot	Contour plot

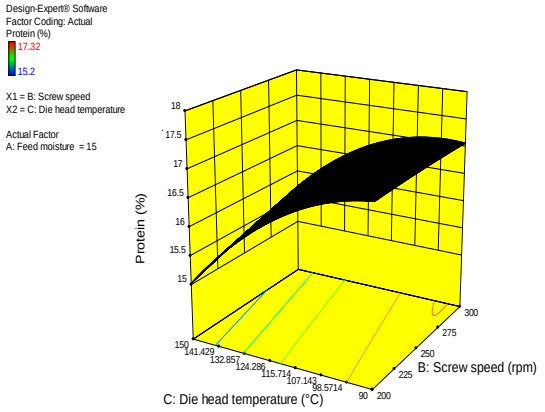
Fig. 2.20 Effect of feed moisture content and screw speed on protein content.

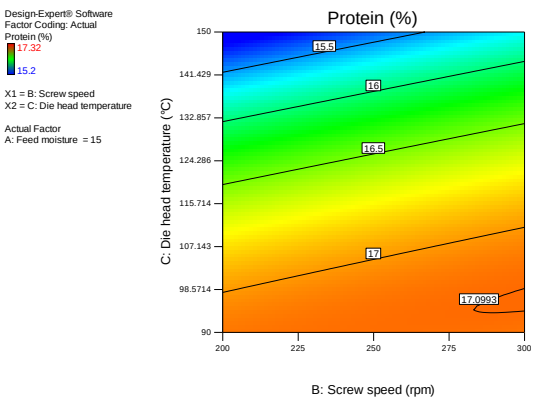




Response surface plot	Contour plot

Fig. 2.21 Effect of feed moisture content and die head temperature on protein content.

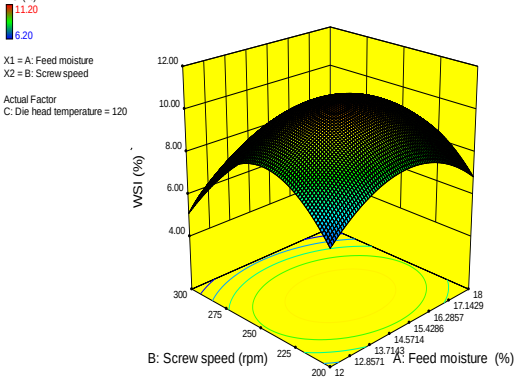


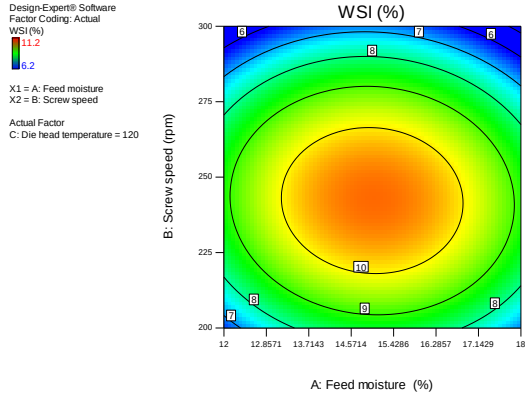


Response surface plot	Contour plot

Fig. 2.22 Effect of die head temp. and screw speed on protein content.

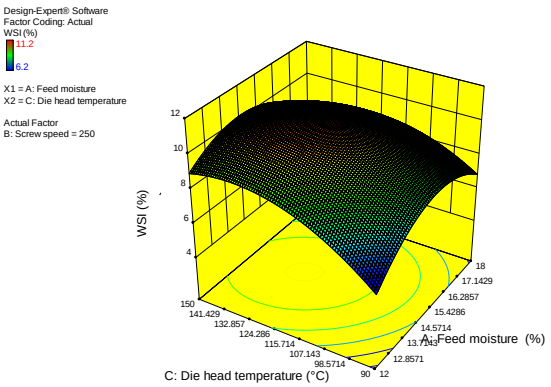
8. Water solubility index

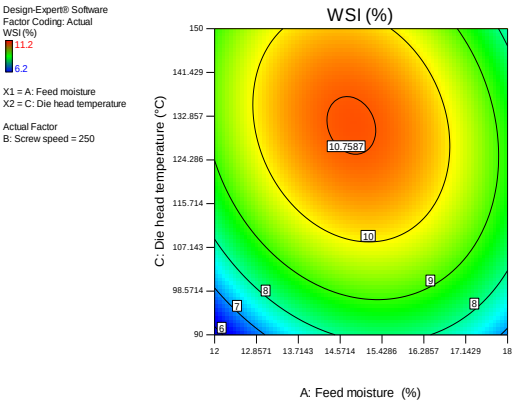




Response surface plot	Contour plot

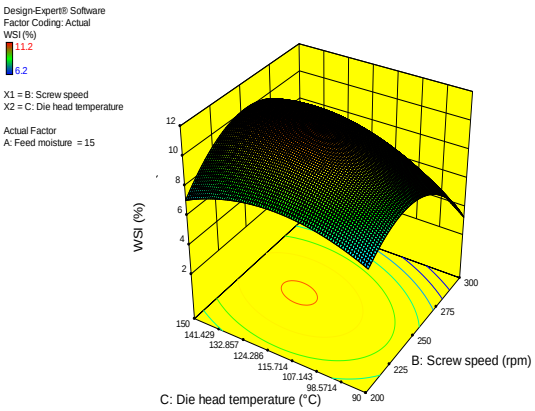
Fig. 2.23 Effect of feed moisture content and screw speed on Water solubility index.

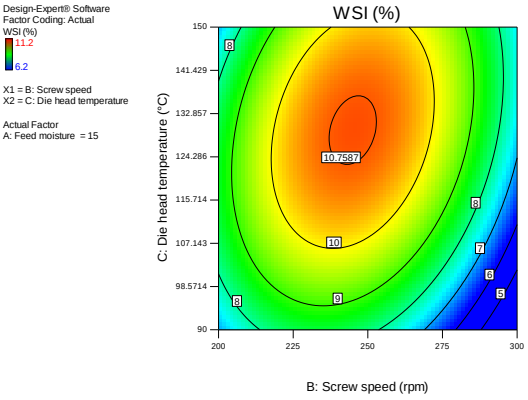




Response surface plot	Contour plot

Fig. 2.24 Effect of feed moisture content and die head temperature on Water solubility index.

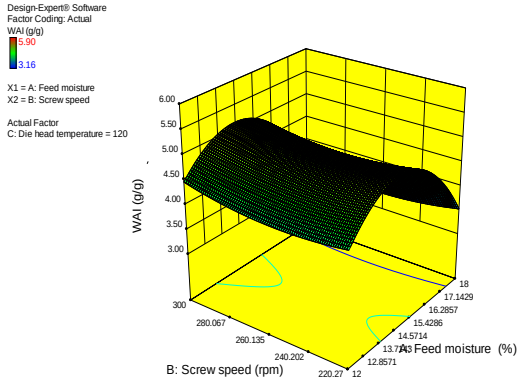


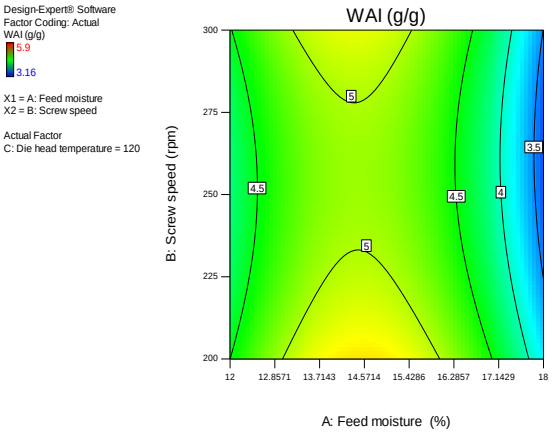


Response surface plot	Contour plot

Fig. 2.25 Effect of die head temp. and screw speed on Water solubility index.

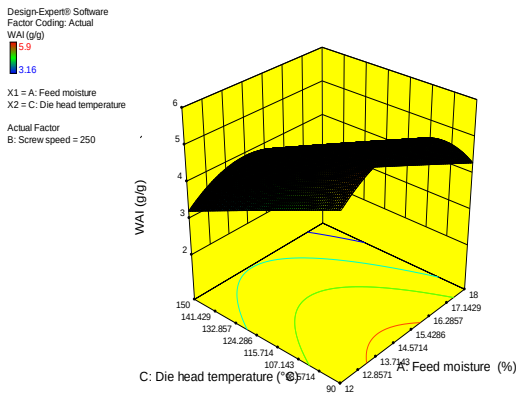
9. Water absorption index

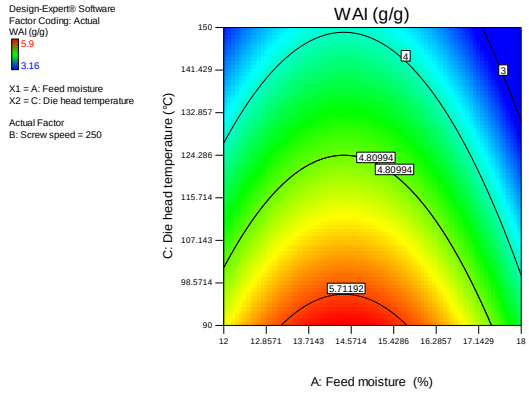




Response surface plot	Contour plot

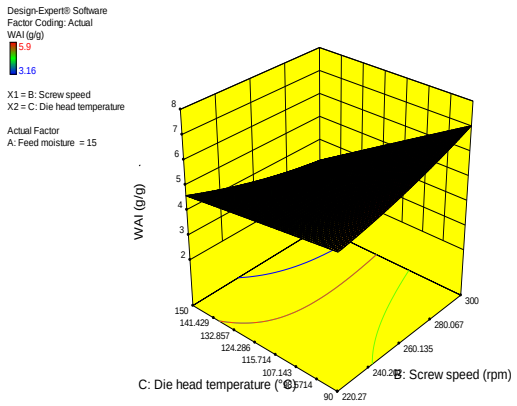
Fig. 2.26 Effect of feed moisture content and screw speed on Water absorption index.

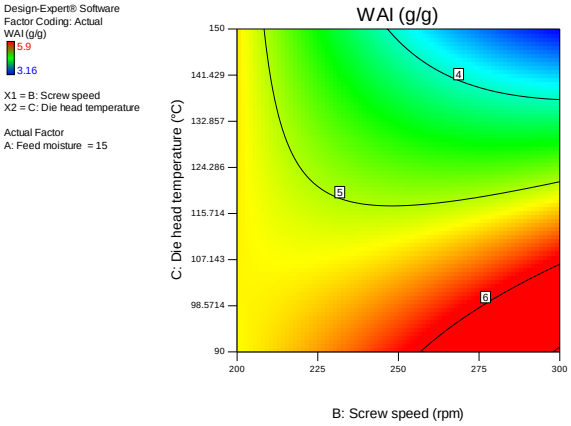




Response surface plot	Contour plot

Fig. 2.27 Effect of feed moisture content and die head temperature on Water absorption index.

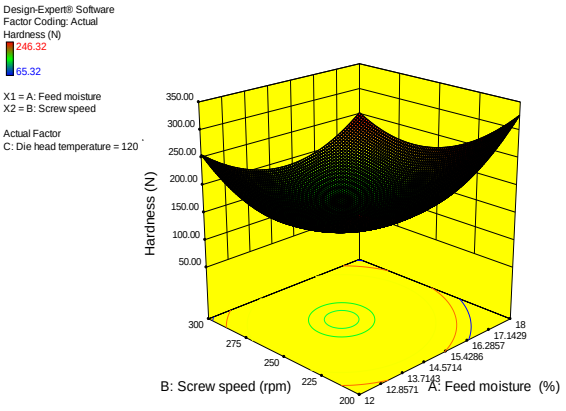


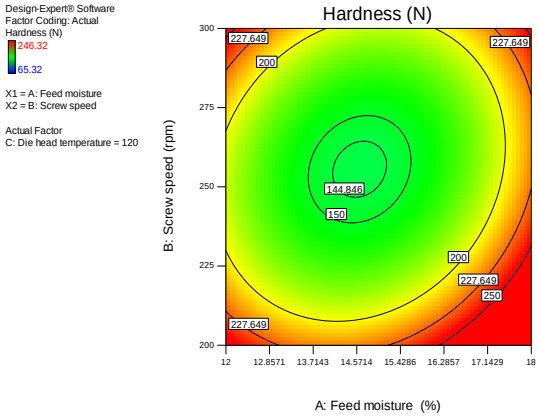


Response surface plot	Contour plot

Fig. 2.28 Effect of die head temp. and screw speed on Water absorption index.

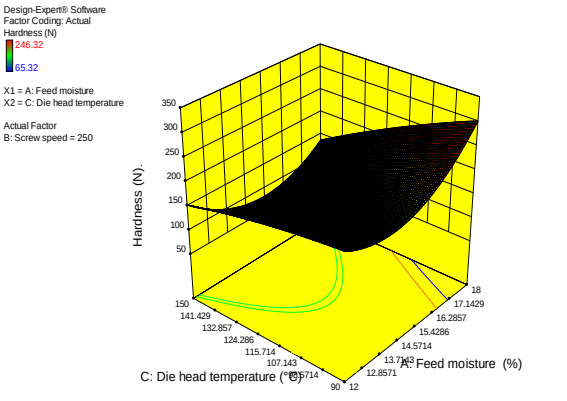
10. Hardness

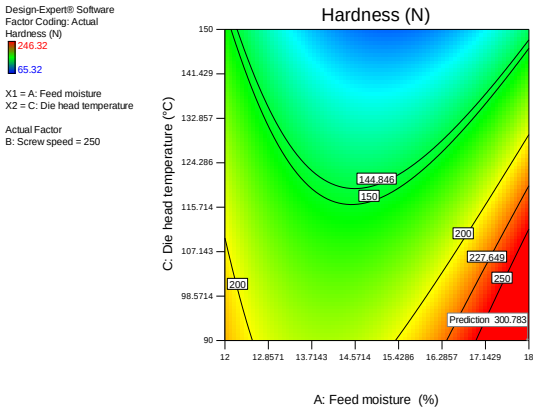




Response surface plot	Contour plot

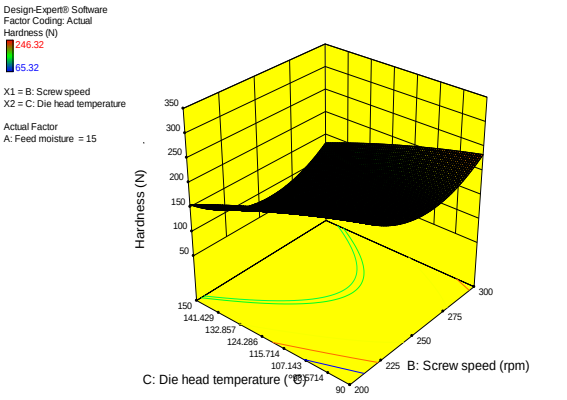
Fig. 2.29 Effect of feed moisture content and screw speed on hardness.

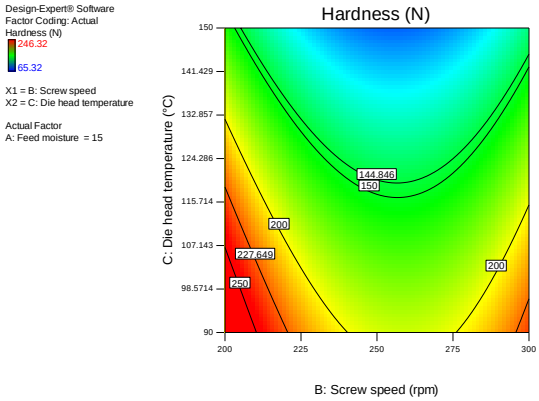




Response surface plot	Contour plot

Fig. 2.30 Effect of feed moisture content and die head temperature on hardness.

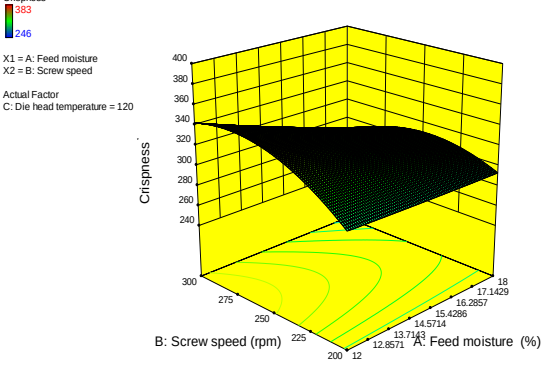


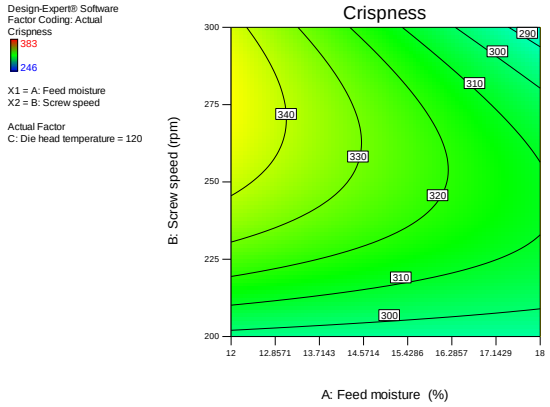


Response surface plot	Contour plot

Fig. 2.31 Effect of die head temp. and screw speed on hardness.

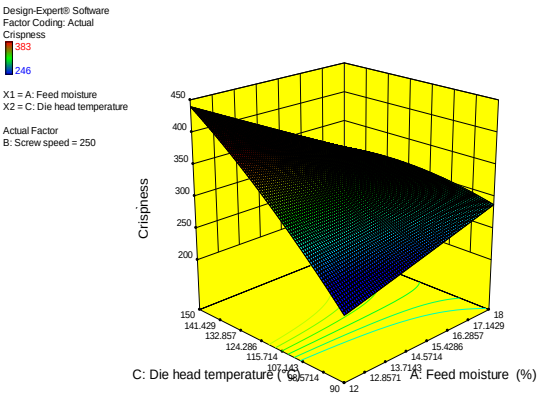
11. Crispness

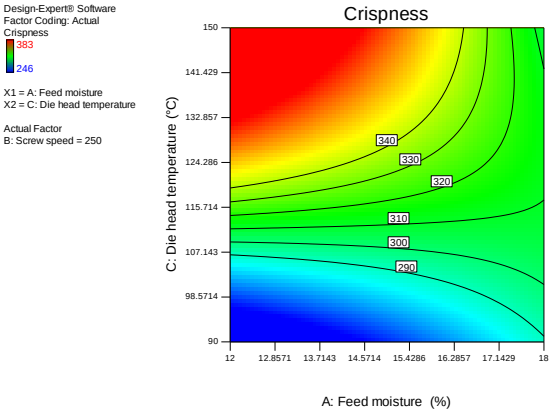




Response surface plot | **Contour plot**

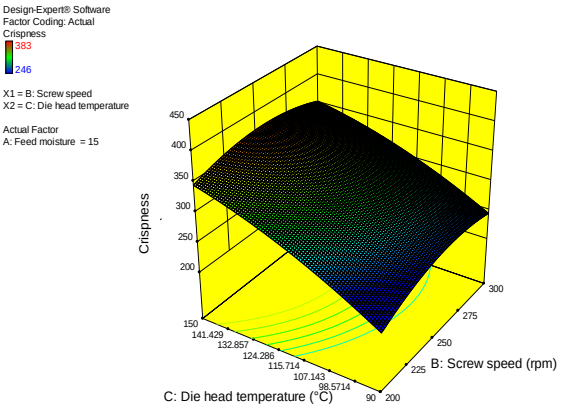
Fig. 2.32 Effect of feed moisture content and screw speed on crispness.

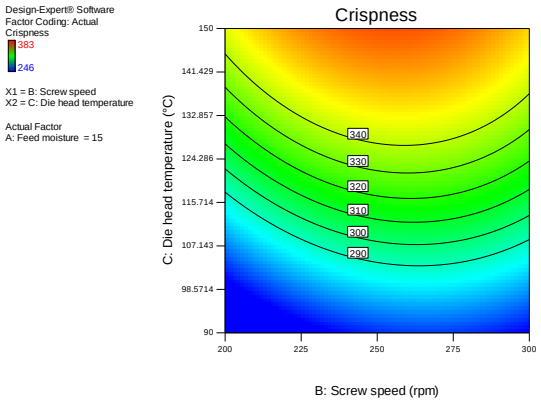




Response surface plot | **Contour plot**

Fig. 2.33 Effect of feed moisture content and die head temperature on crispness.

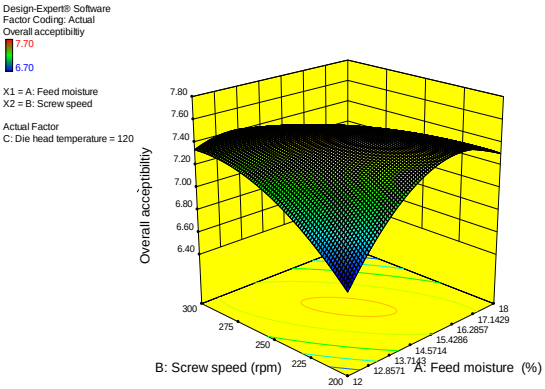


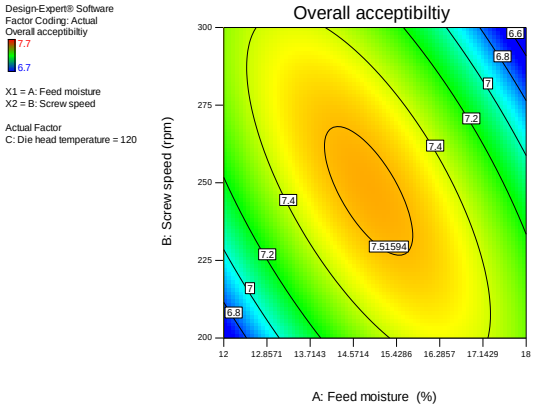


Response surface plot | **Contour plot**

Fig. 2.34 Effect of die head temperature and screw speed on crispness.

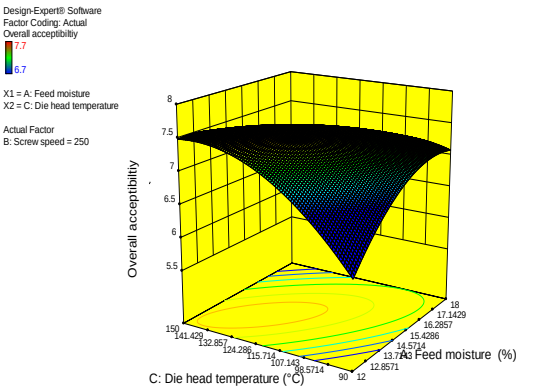
12. Overall acceptability

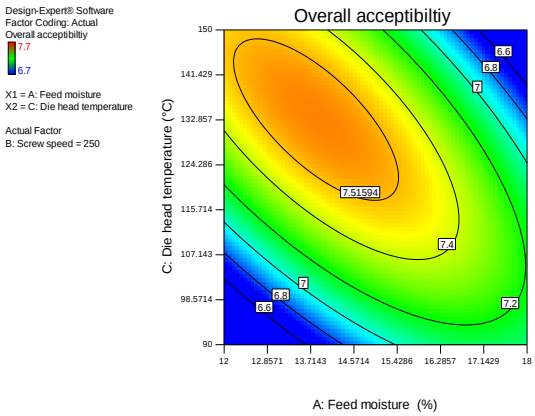




Response surface plot	Contour plot

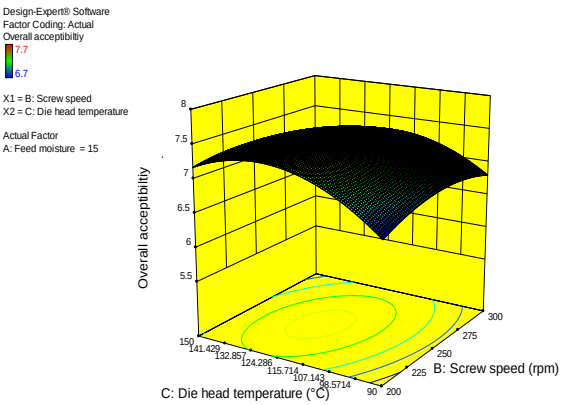
Fig. 2.35 Effect of feed moisture content and screw speed on overall acceptability.

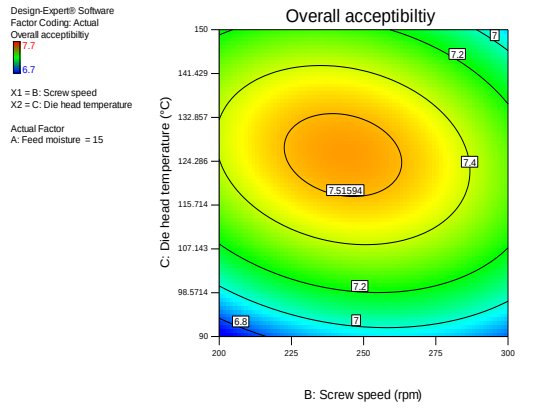




Response surface plot	Contour plot

Fig. 2.36 Effect of feed moisture content and die head temperature on overall acceptability.





Response surface plot	Contour plot

Fig. 2.37 Effect of die head temperature and screw speed on overall acceptability.

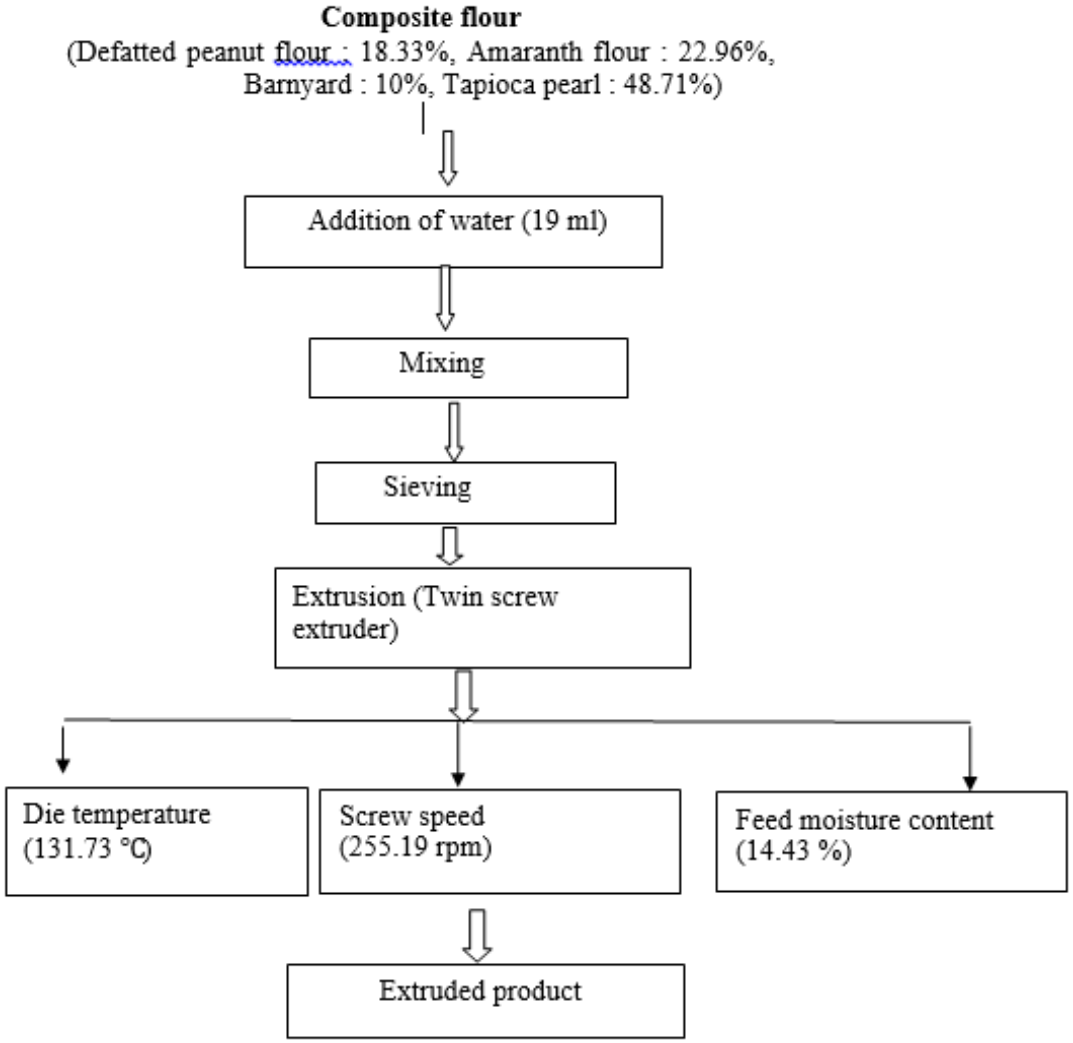
❖ **Optimization and validation of process variables**

Table 2.8. Constraints, criteria and output for numerical optimization of extruded product suitable for fasting.

Variables				
Constraint	**Goal**	**Importance**	**Experimental value**	**Optimum value**
Die temperature	In the range	3	131	131.73
Screw speed (rpm)	In the range	3	255	255.19
Feed moisture content (%)	In the range	3	14	14.43

Responses					
Constraint	**Goal**	**Importance**	**Predicted value**	**Experimental value**	**Deviation (%)**
Torque	None	3	21.17	20	5.52
Mass flow rate	None	3	222.97	240	7.63
Bulk density	None	3	0.050	0.0554	10.8
Expansion ratio	Maximum	3	4.31	4.12	4.40
Moisture content	None	3	8.68	7.78	10.36
Carbohydrates	None	3	67.79	73.55	8.49
Protein	Maximum	3	16.24	17.68	8.86
WSI	Maximum	3	10.69	8.85	17.21
WAI	None	3	4.50	4.80	6.66
Hardness	Minimum	3	123.10	132.50	7.63
Crispness	Maximum	3	354.95	361	1.70
Overall acceptability	Maximize	3	7.55	7.25	3.97

❖ **Improved method suggested for development of protein enriched Ready-to-Eat extruded product ideal for fasting**



11. Financial Implications (Rs. in Lakhs)

11.1 Expenditure on

(a) Manpower : Rs. 32.00

(b) Research/Recurring Contingencies: Rs 0.32

(c) Non-Recurring Cost (Including cost of equipment) : Rs. 0.00

(d) Any Other Expenditure Incurred

11.2 Total Expenditure : Rs. 32.32

12. Cumulative Output

a. Special attainments/innovations

-

b. 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 : --

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

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

e. Details of technology developed : (Crop-based; Animal-based, including vaccines; Biological – biofertilizer, biopesticide, etc; IT based – database, software; Any other – please specify)
- Process technology has been developed for the preparation of high protein extruded product using defatted peanut flour (crop-based)

f. Trainings/demonstrations organized : Yes. Demonstration is given to snack manufacturers during industry meet held on 16-10-2024 on the occasion of World Food Day.

g. Training received : Nil

i. Any other relevant information : The technology developed for preparation of extruded product suitable for fasting will be useful to the snack manufacturers for improving the nutritional value (protein content) of the snack product. Further, the proposed process technology will suggest optimized process for the preparation of extruded snack product suitable for fasting which is nowhere available in the market.

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. To develop extruded product from defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour at different blending ratio	1. Procurement, of raw materials for preparation of extruded product. 2. Quality analysis of the raw materials	1. Different raw materials like defatted peanut flour, amaranth flour, barnyard millet flour and tapioca pearl flour were purchased from the market and concerned suppliers. 2. Proximate analysis of these raw materials was carried out in the laboratory as per the standard methods	All the activities were completed and envisaged output was achieved	100%

	3. Preliminary laboratory trials to study the process 4. Preparation of extruded product as per the final treatments	3. Preliminary trials were carried out to standardised the process 4. The experiments to prepare the extruded products suitable for fasting was carried out as per the decided treatments.		
2. To optimize the blending ratio of defatted peanut flour, amaranth flour, barnyard millet flour and tapioca flour for the preparation of extruded products based on sensory parameters	Sensory analysis of different extruded products to study effect of different process parameters on its sensory quality.	Developed extruded products were analysed for its sensory characteristics following the standard methods. The data of sensory parameters were analysed through Design Expert software to get the optimized flour proportion.	All the activities were completed and envisaged output was achieved	100%
3. To develop extruded product from peanut flour and other fasting food materials under different processing conditions	Preparation of extruded product as per the treatments decided for optimization of processing conditions	Experimental trials were carried out by taking the flour proportion at the optimized levels by varying the different processing parameters	Output is achieved	100%

4. To evaluate the physico-chemical, functional and sensory properties of developed extruded products	Physico-chemical and sensory analysis of the developed extruded products	Developed extruded products were analysed for their physico-chemical and sensory quality	Output is achieved	100%
5. To optimize the processing condition for the development of protein enriched extruded product suitable for fasting	Optimization of the processing parameters based on the experimental data	Data of physico-chemical and sensory properties were analysed as per the Response Surface Methodology (RSM) using Design Expert software. Numerical optimization was carried out to get the optimum treatment condition for the preparation of extruded product suitable for fasting. 2. Research report was prepared and submitted to PC, AICRP on PHT	Output is achieved	100%

(b) Reasons of shortfall, if any : -Nil-

1. Efforts made for commercialization/technology transfer: The procedure for preparation of protein enriched extruded product suitable for fasting was demonstrated to the entrepreneurs and snack manufacturers during industry meet held on 16-10-2024 on the occasion of World Food Day. The demonstrations are also arranged for the students as well as new entrepreneurs as and when they visited the department. Further efforts will be made for commercialization of such product and for the utilization of defatted peanut flour in the preparation of extruded product suitable for fasting.
2. (a) How the output is proposed to be utilized?

   The output as obtained from the project will be commercialised by suggesting the optimized method to the snack manufacturing unit working in the nearby area.

(b) How it will help in knowledge creation?

The interested students as well as other entrepreneurs will also be informed about the use of useful ingredients for preparation of fasting snack product with protein enrichment.

3. Expected benefits and economic impact(if any)

The technology developed will be the best option for preparation of extruded product suitable for fasting. The incorporation of defatted peanut flour in the preparation of such extruded product has certainly improved its protein content and ultimately this product will proved to be the best snack product to issue the problem of malnutrition in the child. It will be new and alternate snack product for the people who are seeking for such product which can be consumed during fasting.

4. Specify whether the project requires submission of RPP-IV for up scaling of research output. - No
5. Future line of research work/other identifiable problems
    1. Training programmes will be arranged for the students and entrepreneurs.
    2. The demonstration will be provided to all interested ones to aware them and to provide hands on training.
6. Details on the research data (registers and records) generated out of the project deposited with the institute for future use
7. Signature of PI, CC-PI(s), all Co-PIs

P. R. Davara Principal Investigator		**M. N. Dabhi** Co-PI	**A. M. Joshi** Co-PI

8. Signature of Head of Division

9. Observations of PME Cell based on Evaluation of Research Project after Completion
10. 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

ONGOING INVESTIGATION – I

RPP- II

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/2023/1
2. Project Title: Management of insect pest of storage wheat in bin by ozone.
3. Reporting Period: January 2024 to September 2024
4. Project Duration: Date of Start –April 2024 Likely Date of Completion –2025
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.	Prof. D. V. Khanpara Assistant Entomology , AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., JunagadhAgril. University, Junagadh	PI	75%	We have fabricated good quality 20 GI metal cylindrical storage bins (100 kg capacity). The wheat purchase procedure was done during month of March and mid-May. Initial observations on moisture per cent, pest infestation and germination were taken as per technical programe. The wheat was filled in bins as per treatment and sealed air tightly. Then after, ozone treatment was started during month of June 2024. The treatments is given as per treatment

				schedule in each bin. The trial is continuing. Monthly observations on pest infestation is recorded.
2.	Prof. A. M. Joshi Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., JunagadhAgril. University, Junagadh	Co-PI	15%	To assist the PI in all above aspects
3.	Dr. M. N. Dabhi, Research Engineer, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., JunagadhAgril. University, Junagadh.	Co-PI-II	10%	Supervision and Co-ordination

5. (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. Fabrication of 20 GI metal cylindrical storage bins and purchase 2. To procurement of ozone machine 3. To procurement of good quality wheat seed	Prof. D. V. Khanpara, Prof. A. M. Joshi, Dr. M. N. Dabhi	1. The bin is purchased according to new rules to purchase through GeM. 2. The ozone machine was procured. 3. Good quality wheat seed was purchased from market.	100% 100 % 100 %

(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)

The wheat purchase procedure was done during month of May. The good quality graded wheat was purchased from open market. The wheat was cleaned and free from pest infestation.

Initial observations on moisture per cent, pest infestation and germination were taken as per technical programe.

The wheat was filled in bins as per treatment and sealed air tightly. Then after, ozone treatment was started during month of June 2024. The treatments is given as per treatment schedule in each bin. Now a day, trial is continuing.

Monthly observations on pest infestation is recorded.

1. Germination per cent

The data (Table No. 1) indicated that the initial percent germination was found 98.0 % to 99.0% and it was not found significant. After three month of storage, per cent germination also not found significant and it was ranged from 96.0 & to 98.5 %.

Table 3.1. Effect of ozone treatments on germination of wheat in bin storage.

Sr. No.	Treatments	Germination % at	
		Initial	90 days
1	Three doses of ozone @ 1000 mg/120 minute after installation	98.5	98.5
2	Four doses of ozone @ 1000 mg/120 minute after installation	98.0	98.0
3	Five doses of ozone @ 1000 mg/120 minute after installation	99.0	98.0
4	Six doses of ozone @ 1000 mg/120 minute after installation	98.5	98.0
5	Seven doses of ozone @1000 mg/120 minute after installation	98.0	98.0
6	Eight doses of ozone @ 1000 mg/120 minute after installation	98.0	98.0
7	Nine doses of ozone @ 1000 mg/120 minute after installation	99.0	97.5
8	Ten doses of ozone @ 1000 mg/120 minute after installation	98.5	97.5
9	Eleven doses of ozone @ 1000 mg/120 minute after installation	98.0	96.0
10	Control(Untreated)	98.0	98.5
	S.Em +/-	**1.16**	**1.14**
	C.D. at 5%	**NS**	**NS**
	C.V.%	**2.36**	**2.33**

2. Moisture per cent

The percent moisture content of grain was found 6.40 % to 6.83 % at initial time of trial and it was found non-significant. (Table No. 2)

Table 3.2. Initial moisture per cent of wheat in bin storage

Sr. No.	Treatments	Initial Moisture %
1	Three doses of ozone @ 1000 mg/120 minute after installation	6.61
2	Four doses of ozone @ 1000 mg/120 minute after installation	6.41
3	Five doses of ozone @ 1000 mg/120 minute after installation	6.60
4	Six doses of ozone @ 1000 mg/120 minute after installation	6.40
5	Seven doses of ozone @1000 mg/120 minute after installation	6.41
6	Eight doses of ozone @ 1000 mg/120 minute after installation	6.60
7	Nine doses of ozone @ 1000 mg/120 minute after installation	6.83
8	Ten doses of ozone @ 1000 mg/120 minute after installation	6.50
9	Eleven doses of ozone @ 1000 mg/120 minute after installation	6.69
10	Control(Untreated)	6.72
	S.Em +/-	**0.20**
	C.D. at 5%	**NS**
	C.V.%	**6.00**

3. Insect pest infestation

The results showed (Table No. 3) that the insect infestation was not observed up to 90 days after installation of trial in all the treatments.

Table 3.3. Pest infestation in bin storage wheat

Sr. No.	Treatments	Pest infestation after installation at			
		Initial	30 days	60 days	90 days
1	Three doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
2	Four doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
3	Five doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
4	Six doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
5	Seven doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
6	Eight doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
7	Nine doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
8	Ten doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
9	Eleven doses of ozone @ 1000 mg/120 minute after installation	Nil	Nil	Nil	Nil
10	Control(Untreated)	Nil	Nil	Nil	Nil

The wheat stored in jute bag at atmospheric condition are infested.

Results:

The results showed (Table No. 3) that the insect infestation was not observed up to 90 days after installation of trial in all the treatments.

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
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)

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: Nil

h. Any other relevant information : Nil

9. Constraints experienced, if any: Nil

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 [7]

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

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

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

NEW INVESTIGATION – I
(Approved in review meeting)
RPP - 1

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: Protein extraction from deoiled castor seeds cake through microbial intervention.
3. Type of research project: ~~Basic~~/Applied~~/Extension/Farmer Participatory/Other~~ (specify)
4. Genesis and rationale of the project :

Castor (*Ricinus communis*) being most valuable oilseed crop in world, is a low priced commodity which is rich in oil percentage. India has good performance in production of castor seeds and oils i.e. 0.36 lakh tonne and 0.10 respectively lakh tonne (2020-21). With high production of oilseeds and oils, India exported the castor oil 734.34 ('000 tonnes) and earn Rs. 6801.99 crore in 2020-21. (Agricultural Statistics at a Glance - 2022).

In India, the major castor producing states are Andhra Pradesh, Gujarat, Karnataka, Odisha, Rajasthan and Tamil Nadu. Gujarat is the India's largest producer of castor in India, accounting for about 85.09 per cent in total production of castor in the country (2019-20). The productivity of castor in Gujarat is the highest not only in India but also in the World. Area, production and yield of castor in Gujarat is 650.27 thousand hectare, 1401.33 thousand tonne and 2155 kg./hectare respectively in 2021-22. Gujarat also played a vital role in Indian economy in export of castor oil. (Ministry of Agriculture and Farmers Welfare Department of Agriculture and Farmers Welfare, Government of India**).**

The castor bean contains oil that makes up approximately 50% of the mass of the bean (w/w, dry mass). The oil has special characteristics, such as high viscosity, heat and pressure stability, a low freezing point, and the ability to form waxy substances after chemical treatments (Conceição et al., 2005). The castor bean is also used for the biodiesel production; in recent years, Brazilian research has focused on the development of a process to produce biodiesel from castor beans (Gutarra et al., 2005). After a trans-esterification reaction, an unwanted by-product referred to as castor bean residue is produced (Godoy et al., 2009).

The castor bean residue, or cake, that remains after the extraction of the oil comprises about one half of the castor bean's weight (Robb et al., 1974). The residue has a protein content of 34–36%. When the beans are decorticated, the protein content of the cake can be increased to 60% (Mottola et al., 1968), potentially making it an excellent source of protein. Now a days, castor meal is applied as organic nitrogenous

fertilizers, soil conditioners, and pesticides for nematodes and insects, and used for the production of industrial enzymes, antibiotics, biopesticides, vitamins and other biochemicals. Due to their rich protein content it is also used as feed supplement for sheep, cattle and poultry after applying detoxification process.

Despite its availability and high protein content, castor bean residue is not used widely as a protein supplement for the feed stuff due to its toxicity; mainly, it is used as an organic fertilizer. Ricin is the most lethal of the toxins found in castor bean residue and is reported to make up as much as 1.5% (w/w, in defatted cake). The other three toxins present in castor bean residue are ricinine, Ricinus communis agglutinin and allergen CB-1A. These three toxins are present in lower concentrations and have relatively insignificant toxic effects, rendering them negligible when considering the use of castor bean residue as animal feed. For this reason, any attempt to detoxify castor bean residue should be aimed at removing ricin only (Anandan et al., 2005). Ricin detection is possible, with the help of protein electrophoresis.

Currently the growing world population places a demand on agricultural and food industries to increase the production of safe and nutritious foods for people and feed for livestock. Plant and animal agricultural byproducts derived after extraction of a high value component can provide lower cost sources, which is particularly important for animal feed and human food. The world demand for additional protein supplies has encouraged studies and exploitation of various inedible protein-rich byproducts. One of these is castor bean meal which contains about 40% of crude protein. In the present study, we want to investigate the effectiveness of novel biotechnological approach based on acid lactic bacteria fermentation to detoxify castor meal and to improve its protein quality through supplementation with the essential amino acids. The results indicate that fermented protein product has good nutritional profile with high level of protein and essential amino acids and is free of toxic components. (Ruzalia U. *et al*. 2013)

LAB have been increasingly used for cereals, pulses and defatted peanut flour fermentation widely in the last decade. Lactic acid fermentation can affect the structure and content of legume protein. This can be attributed to the proteolytic activity of bacteria mechanism during fermentation, by which the polypeptide chain is broken down, and new polypeptides with a lower molecular weight are formed (Lampart-Szczapa et al., 2006). The changes in protein conformation and structure alter the functionality and nutritional properties of the final products (Sozer, N. et al., 2019).

The LAB species such as *Streptococcus thermophilus*, *Lactobacillus delbrueckii subsp. bulgaricus*, *Lactobacillus acidophilus*, *Lactobacillus helveticus* and *Lactobacillus plantarum* have been frequently reported for their positive effects on the organoleptic properties of legume protein (El Youssef, C. *et al*., 2020).The development of LAB during protein fermentation helps the improvement of aroma and flavor by either reducing the occurrence of compounds responsible for off-flavor or masking undesirable green notes (Ben-Harb, S. *et al*., 2019). LAB fermentation is also an effective way for partial or complete degradation of anti-nutritional factors and improvement of protein bioavailability and digestibility (Czarnecka, M. *et al*., 1998).

Taking into account the positive effects of LAB fermentation on the many cereals, pulses, defatted peanut flour and the drop in pH due to lactic acid formation,

the aim of the present study was to explore an extraction method of castor seed proteins based on high power sonication and fermentation, where the decrease in pH was achieved by lactic fermentation instead of mineral acid addition. Three different commercial LAB strain or starters were selected for their aptitude for acidification and / or their recognized positive effect on protein properties: *Streptococcus thermophilus*, *Streptococcus diacetylactis* and *Lactobacillus acidophilus*. The fermentation-assisted extraction was expected to modify the protein profile isolated with this process. To evaluate this effect, extraction yield of protein isolates were evaluated by response surface methodology. Other biochemical, functional and physical properties of the samples were further analyzed to evaluate proteins which are extracted from defatted peanut flour. (Ruzalia U. *et al*. 2013).

The generally regarded safe (GRAS) status and long history of lactic acid bacteria (LAB) as essential ingredients of fermented foods and probiotics make them a major biological tool against a great variety of food-related toxins like bacterial toxins (Shiga-toxin, listeriolysin, Botulinum toxin), mycotoxins (aflatoxin, ochratoxin, zearalenone, fumonisin), pesticides of different classes (organochlorine, organophosphate, synthetic pyrethroids), heavy metals, and natural antinutrients such as phytates, oxalates, and cyanide-generating glycosides. (Penka P. *et al*, 2022).

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

The castor bean mainly used for the oil extraction and limited use of the bio-diesel production also. After, oil extraction, the deoiled cake of the castor bean contains almost 50 % mass. The residue has a protein content of 34–36%. When the beans are decorticated, the protein content of the cake can be increased to 60% (Mottola et al., 1968), potentially making it an excellent source of protein. Now a days, castor meal is applied as organic nitrogenous fertilizers, soil conditioners, and pesticides for nematodes and insects, and used for the production of industrial enzymes, antibiotics, biopesticides, vitamins and other biochemicals. Due to their rich protein content it is also used as feed supplement for sheep, cattle and poultry after applying detoxification process.

Despite its availability and high protein content, castor bean residue is not used widely as a protein supplement for the feed / food stuff due to high ricin content which is highly toxic. The other three toxins are also present in castor bean residue which are the ricinine, Ricinus communis agglutinin and allergen CB-1A. These toxins are present in lower concentrations and have generally, relatively insignificant toxic effects.

Currently the growing world population places a demand on agricultural and food industries to increase the production of safe and nutritious foods for people and feed for livestock. Deoiled cake of the castorseed is the best source of the protein supplement. In the present study, we want to investigate the effectiveness of novel biotechnological approach based on lactic acid producing bacteria which is used for the fermentation to detoxify castor meal and to improve its protein quality through supplementation with the essential amino acids.

LAB have been increasingly used for cereals, pulses and defatted peanut flour fermentation in the last decade. Lactic acid fermentation can affect the structure and

content of the protein content. This can be attributed to the proteolytic activity of bacteria mechanism during fermentation, by which the polypeptide chain is broken down, and new polypeptides with a lower molecular weight are formed (Lampart-Szczapa et al., 2006).

The development of LAB species like *Streptococcus, Lactobacillus* etc. during protein fermentation helps the improvement of aroma and flavor by either reducing the occurrence of compounds responsible for off-flavor or masking undesirable green notes (Ben-Harb, S. *et al*., 2019). LAB fermentation is also an effective way for partial or complete degradation of anti-nutritional factors and improvement of protein bioavailability and digestibility (Czarnecka, M. *et al*., 1998).

Taking into account the positive effects of LAB fermentation on the many cereals, pulses, defatted peanut flour and the drop in pH due to lactic acid formation, the aim of the present study was to explore an extraction method of castorseed proteins based on high power sonification and fermentation, where the decrease in pH was achieved by lactic fermentation instead of mineral acid addition. Three different commercial LAB strain or starters were selected for their aptitude for acidification and / or their recognized positive effect on protein properties: *Streptococcus thermophilus*, *Streptococcus diacetylactis* and *Lactobacillus acidophilus*. The fermentation-assisted extraction was expected to modify the protein profile isolated with this process. To evaluate this effect, extraction yield of protein isolates were evaluated by response surface methodology. Other biochemical, functional and physical properties of the samples were further analyzed to evaluate proteins which are extracted from defatted peanut flour.

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

- Emkani M. et al (2021) studied pea protein extraction through lactic fermentation. In this study, pH was reduced by lactic fermentation instead of mineral acid addition. Different bacterial strains viz. *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium lactis* are used for the protein extraction. Total nitrogen content and protein nitrogen content of globulin fraction was observed ~ 14.5 % and ~ 9.5 % respectively. While total nitrogen content and protein nitrogen content of albumin fraction was observed ~ 11 % and ~ 7 % respectively. Nitrogen extraction yield of globulin and albumin fractions was found ~ 48 % and ~ 35 % respectively. In this study, SDS-PAGE was also performed for polypeptide profiling. Globulin-rich sample profiles revealed the presence of bands ranging from 10 to 99 kDa, characteristic of pea proteins. Various subunits of vicilin including the monomer (Vαβγ, ~50 kDa, Vαβ, ~30–36 kDa, Vβγ, ~25–30 kDa, Vα, ~20kDa, Vβ, ~13kDa, Vγ, ~12–16 kDa), legumin monomer (Lαβ, ~60kDa) and the higher-molecular-weight bands corresponded to lipoxygenase (LOX ~94 kDa) and convicilin (CV, ~71 kDa) was observed while in albumin rich sample profiles also showed clear bands of LOX, lectine (Lect, ~17 kDa) and some contaminations by globulin polypeptides, mainly Vαβ.
- Gayol *et al*. (2013) reported the optimization of protein concentration process from residual peanut oil cake (POC). Different protein extraction and precipitation conditions were used: water/flour ratio (10:1, 20:1 and 30:1), pH (8.0, 9.0 and 10.0), NaCl

concentration (0 and 0.5 M), extraction time (30, 60 and 120 mins.), temperature (25, 40 and 60^{o}C), extraction stages (1, 2 and 3), and precipitation pH (4.0, 4.5 and 5.0). The extraction and precipitation conditions which showed the highest protein yield were 10:1 water / flour ratio, extraction at pH 9.0, without NaCl, 2 staeges of 30 mins. At 40^{o}C and precipitation at pH 4.5. Under these conditions, the peanut protein concentrate (PC) obtained 86.22 % protein, while the initial POC had 38.04 %.

- Gao Z. et al. (2020) studied the impact of alkaline extraction pH (8.5, 9.0, and 9.5) on chemical composition, molecular structure, solubility and aromatic profile of pea protein isolate (PPI). They observed that protein recovery yield increased from 49.20% to 57.56% as the alkaline extraction pH increased from 8.5 to 9.5.pH 9.0 was found to be the optimal condition for preparing premium PPI in terms of yield, functionality, and aromatic profile using alkaline extraction-isoelectric precipitation process. PPI extracted at pH 9.0 possessed the lowest beany flavor The lowest lipoxygenase activity at pH 9.0 may contribute to the least beany flavor in PPI.
- Gore et al (2022) analysed proteins from different varieties of groundnut seeds through SDS-PAGE profiling. Protein fraction viz. albumin, globulin, glutelin and prolamin were extracted during the study, in which albumin % and globulin % content found to be in range of 16.2 to 20.43 % and 72.05-78.5 % respectively while glutelin % and prolamin % was found to be very lower in all varieties with the mean of 2.17 % and 2.57 % respectively. In SDS-PAGE profiling, it was observed albumin and globulin had the highest MW-Rf values in bands collectively (20–23), whereas glutelin and prolamin had the lowest MW-Rf values bands with ranged between 6-10 and correlation matrix between protein fractionation indicated that globulin was negatively correlated with prolamin and glutelin fraction.
- Ruzalia et al (2013) presented the details of microbial liquid culture method for eliminating toxicity of castor meal and producing concentrated protein product. The research was focused on lactic acid bacteria, important in food industry, agriculture and environment. The conditions of hot alkaline protein extraction from meal were optimized and found to be 25% meal in 0.4% alkali solution at 90oC for 30 min. Streptomyces thermophilicus, Str. diacetilactis and Lactobacillus acidophilus were chosen from the numerous laboratory collections as the most prominent starters for fermentation of alkaline protein extract contained toxic antinutritional compounds. The triple microbial formulation of these cultures was found to be the most effective in rapid development of stable protein curd with adequate nutrition value and protein quality. The, extremely toxic ricin was completely eliminated and the fermented product has good nutritional profile with high level of water-soluble protein and essential amino acids. It was concluded that fermented product may be recommended as a promising acceptable protein source in feed production.

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7. Expertise available with the investigating group/Institute

The PI & Co-PIs of project having enough experience of working in the field of Microbiology, Processing and Food Engineering and Biochemistry. Experts in the field of Processing and Food Engineering. Assistant Biochemist is available from Dept. of Biochemistry & Biotechnology, JAU, Junagadh.

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

- The process technology for the protein extraction from deoiled castor seed cake using physical and biological methods will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology of toxin free protein extraction will be availed to the society.

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

i. Castor growers
ii. Castor seed processors
iii. 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: Protein extraction from deoiled castor seeds cake through microbial intervention.
3. Key Words: Deoiled castor seeds cake, detoxinated protein, fermentation, Sonication.

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 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 Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	• Review collection / literature survey • Collect the bacterial cultures from MTCC, Chandigarh and take a Preliminary trial. • Process development for protein isolate using deoiled cake of castorseeds. • Laboratory trials as per the different treatments. • Physico-chemical analysis of the products. • Data collection and its analysis. • Report writing.
2.	Dr. P. J. Rathod Assistant Biochemist, Dept. of Bio-Technology, JAU, Junagadh	Co-PI-I	15%	To assist the PI to carry out biochemical analysis of the product

3.	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-II	15%	1. To assist the PI to carry out the engineering parameters of the product. 2. To assist the PI in statistical analysis.
4.	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-III	10%	To assist the PI for conseptual planning for the project and related activities

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: 01-01-2025 Likely Date of Completion **:** 31-09-2026

9. (a) Objectives :

- To study the effect of process parameters on recovery of protein isolate from deoiled castor seed cake.
- To determine biochemical and physical properties of protein isolate.
- To determine the functional properties of the protein isolate.

(b) Practical utility :

- The process technology for the extraction of protein using physical and biological methods will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology of protein extraction will be availed to the society.

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.	Review collection	January - 25	March - 25	1. To collect the data on extraction of protein from deoiled castorseed cake. 2. To study the work done in the past.	100 %	--	Prof. A. M. Joshi
2.	Procurement and Quality analysis of proposed product raw material	April – 25	June - 25	Procurement of deoiled castorseed cake and bacterial cultures. Quality will be analysed.	100 %	--	- Prof. A. M. Joshi - Dr. M. N. Dabhi
3.	Preliminary laboratory trials	July - 25	Dec - 25	Preliminary trial run for bacterial growth, protein extraction through fermentation, toxin determination in protein isolate etc. will be carried out.	100 %	--	- Prof. A. M. Joshi, - Dr. P. R. Davara - Dr. P. J. Rathod
4.	Extraction of protein as per the final treatments.	Jan - 26	March - 26	Final treatment trials and quality analysis will be carried out.	--	100 %	- Prof. A. M. Joshi, - Dr. P. R. Davara - Dr. P. J. Rathod
5.	Quality analysis of protein isolates.	April - 26	June – 26	Protein will be analysed for its physical, biochemical and functional quality.	--	100 %	- Dr. P. J. Rathod - Prof. A. M. Joshi, - Dr. P. R. Davara,
6.	Data analysis and report writing	July - 26	Sept - 26	Compilation of collected data and preparation of report	--	100 %	- Prof. A. M. Joshi, - Dr. P. R. Davara, - Dr. M. N. Dabhi

2025												2026								
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Review collection																				
			Procurement and Quality analysis of proposed product raw material																	
						Preliminary laboratory trials														
												Extraction of protein as per the final treatments.								
															Quality analysis of protein isolates.					
																		Data analysis and report writing		

11. Technical Programme (brief)

Justification :

The castor bean mainly used for the oil extraction and limited use of the bio-diesel production also. After, oil extraction, the deoiled cake of the castor seeds contains almost 50 % mass. The residue has a protein content of 34–36%. When the beans are decorticated, the protein content of the cake can be increased to 60% (Mottola et al., 1968), potentially making it an excellent source of protein. Now a days, castor meal is applied as organic nitrogenous fertilizers, soil conditioners, and pesticides for nematodes and insects, and used for the production of industrial enzymes, antibiotics, biopesticides, vitamins and other biochemicals. Due to their rich protein content it is also used as feed supplement for sheep, cattle and poultry after applying detoxification process.

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biotechnological approach based on lactic acid producing bacteria which is used for the fermentation to detoxify castor meal and to improve its protein quality through supplementation with the essential amino acids.

LAB have been increasingly used for cereals, pulses and defatted peanut flour fermentation in the last decade. Lactic acid fermentation can affect the structure and content of the protein content. This can be attributed to the proteolytic activity of bacteria mechanism during fermentation, by which the polypeptide chain is broken down, and new polypeptides with a lower molecular weight are formed (Lampart-Szczapa et al., 2006).

The development of LAB species like *Streptococcus, Lactobacillus* etc. during protein fermentation helps the improvement of aroma and flavor by either reducing the occurrence of compounds responsible for off-flavor or masking undesirable green notes (Ben-Harb, S. *et al*., 2019). LAB fermentation is also an effective way for partial or complete degradation of anti-nutritional factors and improvement of protein bioavailability and digestibility (Czarnecka, M. *et al*., 1998).

Taking into account the positive effects of LAB fermentation on the many cereals, pulses, defatted peanut flour and the drop in pH due to lactic acid formation, the aim of the present study was to explore an extraction method of castorseed proteins based on high power sonification and fermentation, where the decrease in pH was achieved by lactic fermentation instead of mineral acid addition. Three different commercial LAB strain or starters were selected for their aptitude for acidification and / or their recognized positive effect on protein properties: *Streptococcus thermophilus*, *Streptococcus diacetylactis* and *Lactobacillus acidophilus*. The fermentation-assisted extraction was expected to modify the protein profile isolated with this process. To evaluate this effect, extraction yield of protein isolates were evaluated by response surface methodology. Other biochemical, functional and physical properties of the samples were further analyzed to evaluate proteins which are extracted from defatted peanut flour.

Status (review) :

- Emkani M. et al (2021) studied pea protein extraction through lactic fermentation. In this study, pH was reduced by lactic fermentation instead of mineral acid addition. Different bacterial strains viz. *Streptococcus thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium lactis* are used for the protein extraction. Total nitrogen content and protein nitrogen content of globulin fraction was observed ~ 14.5 % and ~ 9.5 % respectively. While total nitrogen content and protein nitrogen content of albumin fraction was observed ~ 11 % and ~ 7 % respectively. Nitrogen extraction yield of globulin and albumin fractions was found ~ 48 % and ~ 35 % respectively. In this study, SDS-PAGE was also performed for polypeptide profiling. Globulin-rich sample profiles revealed the presence of bands ranging from 10 to 99 kDa, characteristic of pea proteins. Various subunits of vicilin including the monomer (Vαβγ, ~50 kDa, Vαβ, ~30–36 kDa, Vβγ, ~25–30 kDa, Vα, ~20kDa, Vβ, ~13kDa, Vγ, ~12–16 kDa), legumin monomer (Lαβ, ~60kDa) and the higher-molecular-weight bands corresponded to lipoxygenase (LOX ~94 kDa) and convicilin (CV, ~71 kDa) was observed while in albumin rich

sample profiles also showed clear bands of LOX, lectine (Lect, ~17 kDa) and some contaminations by globulin polypeptides, mainly Vαβ.

- Gayol *et al*. (2013) reported the optimization of protein concentration process from residual peanut oil cake (POC). Different protein extraction and precipitation conditions were used: water/flour ratio (10:1, 20:1 and 30:1), pH (8.0, 9.0 and 10.0), NaCl concentration (0 and 0.5 M), extraction time (30, 60 and 120 mins.), temperature (25, 40 and 60^{o}C), extraction stages (1, 2 and 3), and precipitation pH (4.0, 4.5 and 5.0). The extraction and precipitation conditions which showed the highest protein yield were 10:1 water / flour ratio, extraction at pH 9.0, without NaCl, 2 staeges of 30 mins. At 40^{o}C and precipitation at pH 4.5. Under these conditions, the peanut protein concentrate (PC) obtained 86.22 % protein, while the initial POC had 38.04 %.
- Gao Z. et al. (2020) studied the impact of alkaline extraction pH (8.5, 9.0, and 9.5) on chemical composition, molecular structure, solubility and aromatic profile of pea protein isolate (PPI). They observed that protein recovery yield increased from 49.20% to 57.56% as the alkaline extraction pH increased from 8.5 to 9.5.pH 9.0 was found to be the optimal condition for preparing premium PPI in terms of yield, functionality, and aromatic profile using alkaline extraction-isoelectric precipitation process. PPI extracted at pH 9.0 possessed the lowest beany flavor The lowest lipoxygenase activity at pH 9.0 may contribute to the least beany flavor in PPI.
- Gore et al (2022) analysed proteins from different varieties of groundnut seeds through SDS-PAGE profiling. Protein fraction viz. albumin, globulin, glutelin and prolamin were extracted during the study, in which albumin % and globulin % content found to be in range of 16.2 to 20.43 % and 72.05-78.5 % respectively while glutelin % and prolamin % was found to be very lower in all varieties with the mean of 2.17 % and 2.57 % respectively. In SDS-PAGE profiling, it was observed albumin and globulin had the highest MW-Rf values in bands collectively (20–23), whereas glutelin and prolamin had the lowest MW-Rf values bands with ranged between 6-10 and correlation matrix between protein fractionation indicated that globulin was negatively correlated with prolamin and glutelin fraction.

Objectives :

- To study the effect of process parameters on recovery of protein isolate from deoiled castor seed cake.
- To determine biochemical and physical properties of protein isolate.
- To determine the functional properties of the protein isolate.

Technical programme

- **Experimental Detail :**

(a) Experimental Design : Response Surface Methodology : CCRD
(3 = 2 numerical factors + 1 categoric factor)

(b) Base material: Deoiled castorseed cake

(c) Bacterial cultures: *Streptococcus thermophilus*, *Streptococcus diacetylactis* and *Lactobacillus acidophilus*.

(Three different bacterial strains will be applied in each treatment)

- **Treatments Detail :**

Independent parameters

Sr. No.	Factor	Code	Coded levels				
			-2	**-1**	**0**	**+1**	**+2**
1	Water to flour ratio	X_1	6	7.5	9	10.5	12
2	Sonication time	X_2	2	4.5	7	9.5	12

- **Treatment combinations :**

Run	Water to Flour Ratio	Sonication time (minutes)
1	9 : 1	2
2	10.5 : 1	9.5
3	7.5 : 1	9.5
4	12 : 1	7
5	9 : 1	12
6	6 : 1	7
7	9 : 1	7
8	9 : 1	7
9	9 : 1	7
10	7.5 : 1	4.5
11	9 : 1	7
12	9 : 1	7
13	9 : 1	7
14	10.5 : 1	4.5

- **Dependent parameters :**

1. Acidification kinetics at 0, 6, 12, 24, 48 and 72 hours	
2. Biochemical parameters	
a) Moisture content b) Oil content	c) Ash content d) SDS-PAGE
3. Physical parameters a) Bulk density b) True density	
4. Functional parameters a) Water absorption index b) Water solubility index c) Protein yield	

- **Methodology :**

Bacterial Cultures
Streptococcus thermophilus,
Streptococcus diacetylactis,
&
Lactobacillus acidophilus

↓

Pre-Cultivation
(skim milk agar with 0.1% Yeast extract)
37°C, 24 hours

↓

Deoiled Castorseed cake

Water (0.4% alkaline) to Flour Ratio
(6:1 to 12:1 - as per RSM design)

↓

Sonication at 100 % amplitude
(2 mins. to 12 mins. – as per RSM design)

↓

Centrifugation at 4000 rpm for 20 minutes

↓

Inoculate each bacterial strains in all treatment flasks @ 10^8 cfu / ml

↓

Sample mixing at 200 rpm, 37°C and fermentation process upto 72 hours

↓ Sampling and pH measurement at 0, 6, 12, 24, 48, 72 hours

Stop the stirrer pH 4.2-4.8

↓

Centrifugation (10,000 rpm, 6 minutes)

↓

Drying of the Fermented Protein Product (FPP)

Process flow chart for preparation of protein from Deoiled Castorseed cake

Possible outputs:

- The process technology for the extraction of castorseed protein using physical and biological methods will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology of toxin free protein extraction will be availed to the society.

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1. Financial Implications (in Lakhs) : Rs. 39.32 lakhs

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

S. No.	Staff Category	Man months	Cost
1.	Scientific	23	35,00,000
2.	Technical	5	4,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	39,00,000

12.2 Research/Recurring Contingency

S. No.	Item	Year(1)	Year (2)	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.		--	--	--	--
2.		--	--	--	--
	Total (Non-recurring)	--	--	--	--

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	20,00,000	19,32,000	--	39,32,000

(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				

ANNEXURE - III

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

1. Project Title: Protein extraction from deoiled castor seeds cake through microbial intervention.
2. Date of Start & Duration : January – 2025 to September - 2026
3. Institute Project [√] or Externally Funded [ ]
4. Estimated Cost of the Project : 39,32,000/- 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

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–III

HOD/PD/I/c

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

1. Institute Name : AICRP on PHET, JAU, Junagadh

2. Project Title: Protein extraction from deoiled castor seeds cake through microbial intervention.

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 INVESTIGATION – 1

(To be presented in 40th Annual Workshop)

RPP - 1

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))

2. Institute Name : College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh

3. Title of the project: Development of jamun leather using refractance window dryer.

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

5. Genesis and rationale of the project :

Underutilized fruit Jamun is delicate and highly perishable when it is ripened and stored for 2-3 days in ambient condition. It is very nutritive and therapeutic valued fruit. Very short season fruit is to be value added for long term use. Value addition through jamun leather is one of the option for its utilization. Refractive window drying is novel technology for removal of moisture from the product. For preparation of leather from jamun pulp will serve the purpose of value addition and utilization of fruit during offseason.

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

Jamun of family Myrtaceae is an important but underutilized fruit crop of India. It is native to India and Myanmar. However, it has naturalized throughout South East Asia and Pacific regions. Perishable fruit surpluses are available in abundance in a particular part of the year and wasted in large quantities due to absence of facilities and knowhow for proper handling, distribution, marketing and storage. Jamun (Syzygium cuminii) is one of the underutilized fruit species, which is neither cultivated in an organized farming system nor processed by established commercial processing methods. Jamun has exotic flavour and is known for its nutritional and therapeutic values. For instance, the fruit syrup is very useful for curing diarrhea. It is effective in stomachache, carminative and diuretic, apart from having cooling and digestive properties. The ripe fruits of jamun contain 83-86 per cent moisture, 0.7-0.13 g proteins, 15-0.30 g fats, 0.3-0.9 g crude fibre, 14 g carbohydrates, 0.3-0.4 g ash, 8.3-15 mg calcium, 35 mg magnesium, 15-16 mg potassium, 1.2-1.62 mg iron, 26.2 mg sodium and 5.7-18 mg ascorbic acid. Other than these, fruits are rich in chlorine, riboflavin, thiamine and sulphur. Jamun fruit is also a good source of anthocyanin pigment (210-242 mg per 100ml of anthocyanin) and phenolic compounds (500 mg per 100g phenolic compounds). The demand for jamun fruit and its processed products like juice, squash and seed powder is on increasing trend both in metropolitan and small cities. There is great scope for the processed products, not only because of their exotic flavour but also due to their nutraceutical and therapeutic values. The fruit is highly perishable and can be stored only for 2-3 days under ambient conditions. However, in cold storage (3-4 ^{o}C and 85-90% Rh) it can be stored for 12 days. Thus, processing of jamun into value

added products results in a wide variety of exotically flavoured products with better nutritional and sensory qualities and can unveil new market for export.

Refractance Window (RW) drying is a novel drying technology for converting puree and slices of fruits and vegetables and the biomaterials into powder, flakes, or sheet and value added products without losing essential heat sensitive nutritional components. It is relatively new drying technique which belongs to the fourth generation of drying techniques. RW drying is included in film (thin) drying technologies having high transfer rates of heat and mass which fastened the drying rate relatively with low temperature of product to give better quality product.

Fruit leather is a dehydrated fruit based product. It is tasty, chewy, semi dried product. It is prepared by pouring pureed fruit onto a flat surface for drying. When dried, the fruit pulp is pulled from surface and rolled and cut in bar shape. The popularity of fruit leather is increasing significantly. It is more healthful than other confection's as it is produced from the whole fruit pulp which contains vitamins. The advantages of making our own fruit leather are to use less sugar and to mix fruit flavours. For diabetic adult or child, fruit leather can be made without sugar. Also the individual fruit leather should contain the amount of fruit allowed for the fruit exchange. Therefore, the present study was undertaken to standardize the protocol for the preparation of jamun fruit bar and to evaluate the storage stability of the developed products.

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

Jamun (Syzygium cumini L.) is an evergreen tropical tree belongs to the family Myrtaceae. The world production of Jamun is estimated at 13.5 million tonnes out of which 15.4 per cent is contributed by India. In the world, India ranks second in production of Jamun. Maharashtra state is the largest producer followed by Uttar Pradesh, Tamil Nadu, Gujarat and Assam. Jamun fruit is is good source of iron, vitamin C and other vital nutrients. Post-harvest value addition of Jamun fruit includes preparation of jam, jelly squash and making powder from Jamun seeds which has great medicinal properties for diabetic patients. (Markam and Tigga, 2021).

Khurdiya and Roy (1985) reported that juice from Jamun was acidic, astringent and therefore, not generally preferred as such. An attempt was made to prepare a ready to serve (RTS) beverage from Jamun juice having 25% juice, 18% TSS and 0.6% acidity. Jamun fruit juice had an attractive colour and excellent taste with some therapeutic value could be profitably utilized by beverage industry.

Refractance Window (RW) drying is a novel drying technology for converting puree and slices of fruits and vegetables and the biomaterials into powder, flakes, or sheet and value added products without losing essential heat sensitive nutritional components. It is relatively new drying technique which belongs to the fourth generation of drying techniques. RW drying is included in film (thin) drying technologies having high transfer rates of heat and mass which fastened the drying rate relatively with low temperature of product to give better quality product. It also provides advantages in terms of energy consumption, impact on environment, dehydration cost, safety, and productivity (Karadbhajne et al.).

Baeghbalia et al. (2018) reported higher total anthocyanins in pomegranate juice drying by RW dried samples in comparison to freeze and spray dried samples. Similaraly antioxidant activity was higher in RW dried samples as comparison to freeze dried sample. Bernaert et al. (2018) reported higher ascorbic acid retention in strawberry puree in RW dried sample as compared to freeze dried sample. RW drying process retains high amount of total flavonoids (86.4, 76.6 and 74.2%) in tomato samples dried at three different conditions (75°C for 60 min., 60°C for 75 min., and 90°C for 40 min.) as comparing to tomato samples dried by convection drying process (50.9%) as well as higher lycopene content was higher in tomato powder under RW dried tomato as compared to convection dried tomato (Abul-Fdl and Ghanem, 2011).

Best quality leather can be prepared in a tray dryer from jamun pulp with addition of 55% sugar and 0.3% pectin having storability up to 6 months (Sood and Bandral 2015).

Physicochemical quality of RW-dried onion powder had higher L*, a*, b* values, chroma, PAC, TPC, TFC and AC, as well as the lowest DE, hue angle and hygroscopicity values compared to convective-dried samples (Shrivastav et al. 2021).

The RW drying method can produce superior quality mango powder compared to drum and spray drying, while it is highly comparable to freeze drying (Caparino et al. 2012).

8. Expertise available with the investigating group/Institute

The PI & Co-PIs 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 to conduct the process activities in the laboratory.

9. 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.

10. (a) Expected output
    - The proposed process technology will suggest the value addition of Jamun fruits.
    - The fruit production industries will have better choice to develop new product.

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

iv. Fruit processing industries ii. 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: Development of jamun leather using refractance window dryer.
3. Key Words : Jamun, Refractance window drying, leather
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 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	70%	• Review collection/literature survey • Designing of the experiment • Procurement of raw materials • Quality analysis of the raw materials • Experimental trials for the optimization of flour proportion of different ingredient food materials • Sensory analysis of extruded products prepared during preliminary trials for the optimization of flour proportion • Optimization of the flour proportion based on the data of sensory parameters obtained for the different extruded product • Laboratory trials for the preparation of peanut and millet based extruded product at the optimized flour proportion as per the experimental treatments • Physico-chemical and sensory analysis of the developed extruded products

				• Data collection and its analysis • Optimization of the processing parameters based on the experimental data • Report writing
2.	Prof. A. M. Joshi, Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI	20%	1. Storage study of jamun leather, 2. Microbiological analysis, 3. To assist the PI in carrying out the different activities of the project as and when needed
3.	Dr. P. J. Rathod Assistant Professor (Biochemistry) Dept. of Biochemistry, College of Agriculture, Junagadh Agril. University, Junagadh	Co-PI	10%	1. Help in biochemical analysis and data interpretation of fresh jamun, dried and stored jamun leather.

7. Priority Area to which the project belongs : Post-Harvest Technology and value addition

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

8. Project Duration: Date of Start: 01-01-2025 Likely Date of Completion **:** 31-03-2026

9. (a) Objectives

1. To study the proximate composition of jamun pulp.
2. To study and optimize the drying parameters of jamun pulp in Refractance window drying.
3. To study the proximate composition of jamun leather.
4. To study the packaging and storage of jamun leather.

(b) Practical utility

1. The jamun leather product will be made available to the food industries.
2. Value addition of jamun fruit will be available.
3. The new product will be available with the refractance window dryer.
4. The proposed process technology will suggest the proper utilization jamun fruit.

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.	Proximate composition of jamun fruit	January-25	April-25	Biochemical parameters of jamun fruit its pulp will be carried out	100 %	--	Dr. M. N. Dabhi Dr. P. J. Rathod
2.	Drying of jamun pulp in Refractance window dryer andoptimize the machine parameters for production of jamun leather	May-25	June-26	Jamun fruit leather will be obtained	100 %	--	Dr. M. N. Dabhi
3.	Quality analysis of the jamun leather	June-25	June-25	Biochemical properties of jamun leather will be carried out.	100 %	--	Dr. M. N. Dabhi Dr. P. J. Rathod
4.	Packaging and Storage study jamun leather	July-25	Jan-26	Packaging of jamun leather and its storage will be carried out. Biochemical and microbial, sensory properties will be obtained during the storage study	100 %	--	Dr. M. N. Dabhi Prof. A. M. Joshi Dr. P. J. Rathod
5.	Data analysis	Jan-26	Feb-26	The data of various bio-chemical and sensory parameters will be collected and	100 %	100 %	Dr. M. N. Dabhi Prof. A. M. Joshi

				statistically analysed			
6.	Report writing	Mar-26	Mar-26	Compilation of collected data and preparation of report	--	100 %	Dr. M. N. Dabhi Prof. A. M. Joshi Dr. P. J. Rathod

11. Technical Programme (brief)

Justification :

Underutilized fruit Jamun is delicate and highly perishable when it is ripened and stored for 2-3 days in ambient condition. It is very nutritive and therapeutic valued fruit. Very short season fruit is to be value added for long term use. Value addition through jamun leather is one of the option for its utilization. Refractive window drying is novel technology for removal of moisture from the product. For preparation of leather from jamun pulp will serve the purpose of value addition and utilization of fruit during offseason.

Status (review) :

Jamun (Syzygium cumini L.) is an evergreen tropical tree belongs to the family Myrtaceae. The world production of Jamun is estimated at 13.5 million tonnes out of which 15.4 per cent is contributed by India. In the world, India ranks second in production of Jamun. Maharashtra state is the largest producer followed by Uttar Pradesh, Tamil Nadu, Gujarat and Assam. Jamun fruit is is good source of iron, vitamin C and other vital nutrients. Post-harvest value addition of Jamun fruit includes preparation of jam, jelly squash and making powder from Jamun seeds which has great medicinal properties for diabetic patients. (Markam and Tigga, 2021).

Khurdiya and Roy (1985) reported that juice from Jamun was acidic, astringent and therefore, not generally preferred as such. An attempt was made to prepare a ready to serve (RTS) beverage from Jamun juice having 25% juice, 18% TSS and 0.6% acidity. Jamun fruit juice had an attractive colour and excellent taste with some therapeutic value could be profitably utilized by beverage industry.

Refractance Window (RW) drying is a novel drying technology for converting puree and slices of fruits and vegetables and the biomaterials into powder, flakes, or sheet and value added products without losing essential heat sensitive nutritional components. It is relatively new drying technique which belongs to the fourth generation of drying techniques. RW drying is included in film (thin) drying technologies having high transfer rates of heat and mass which fastened the drying rate relatively with low temperature of product to give better quality product. It also provides advantages in terms of energy consumption, impact on environment, dehydration cost, safety, and productivity (Karadbhajne et al.).

Baeghbalia et al. (2018) reported higher total anthocyanins in pomegranate juice drying by RW dried samples in comparison to freeze and spray dried samples. Similaraly antioxidant activity was higher in RW dried samples as comparison to freeze dried sample. Bernaert et al. (2018) reported higher ascorbic acid retention in strawberry puree in RW dried sample as compared to freeze dried sample. RW drying process retains high amount of total flavonoids

(86.4, 76.6 and 74.2%) in tomato samples dried at three different conditions (75°C for 60 min., 60°C for 75 min., and 90°C for 40 min.) as comparing to tomato samples dried by convection drying process (50.9%) as well as higher lycopene content was higher in tomato powder under RW dried tomato as compared to convection dried tomato (Abul-Fdl and Ghanem, 2011).

Best quality leather can be prepared from jamun pulp with addition of 55% sugar and 0.3% pectin having storability up to 6 months (Sood and Bandral 2015).

Physicochemical quality of RW-dried onion powder had higher L*, a*, b* values, chroma, PAC, TPC, TFC and AC, as well as the lowest DE, hue angle and hygroscopicity values compared to convective-dried samples (Shrivastav et al. 2021).

The RW drying method can produce superior quality mango powder compared to drum and spray drying, while it is highly comparable to freeze drying (Caparino et al. 2012).

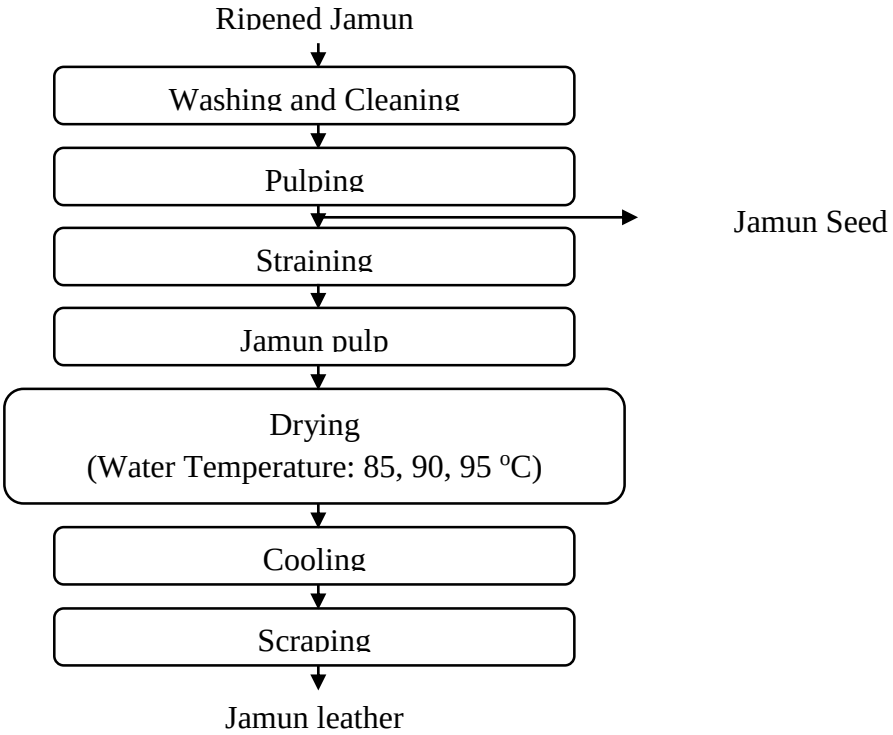
Objectives

1. To study the proximate composition of jamun pulp.
2. To study and optimize the drying parameters of jamun pulp in Refractance window drying.
3. To study the proximate composition of jamun leather.
4. To study the packaging and storage of jamun leather.

Technical programme

❖ **Jamun Leather preparation**

The procedure to be followed for the preparation of jamun leather product using refractance window drying is presented in the process flow chart as given in Fig. 1.



Process flow chart for preparation of Jamun leather leather.

Experimental design

A factorial study of 2 variables at 3 levels combinations for Response Surface Methodology (RSM) for optimizing the drying process parameters.D optimal coordinate exchange design will be used for designing the experiment trials. (Khuri and Cornell, 1987).

Treatment details:

- **Independent parameters :**
  1. Temperature (°C) (X1): Four levels (85, 90, 95)
  2. Thickness (mm) (X2) : Four levels (6, 8, 10)

Dependent parameteres:

- **Drying time, min**
- **Biochemical parameters of extruded product**
  - Moisture content (%)
  - Total sugar (%)
  - Reducing sugar (%)
  - Ascorbic acid (mg/100g)
  - Titrable acidity (%)
  - TSS (Brix)
  - Anthocynin (mg/100g)
  - Tanin (mg/100g)
  - Iron (mg/100g)
- **Sensory parameters**
  - Taste
  - Colour
  - Overall acceptability

Table 5.1 : Experimental run of central composite face centered design for jamun leather

Std.	Run	Coded variable		Uncoded variable	
		X_1	X_2	Water Temperature (^oC)	Thickness of pulp layer (mm)
1	1	-1	-1	85	6
3	2	-1	1	85	10
4	3	1	1	95	10
12	4	0	0	90	8
6	5	1	0	95	8
9	6	0	0	90	8
5	7	-1	0	85	8
7	8	0	-1	90	6
10	9	0	0	90	8
13	10	0	0	90	8
2	11	1	-1	95	6
11	12	0	0	90	8

❖ **Statistical Analysis**

The statistical analysis of the experimental data will be carried out using Design Expert 10.0.7 to observe the significance of the effect of various process parameters on the various response by Khuri and Cornell (1987).

Possible outputs :

- The jamun leather product will be made available to the food industries.
- Value addition of jamun fruit will be available.
- The new product will be available with the refractance window dryer.
- The proposed process technology will suggest the proper utilization jamun fruit.

References :

Khurdiya DS, Roy SK. Processing of rose apple ('Jamun') fruit into a ready-to-serve beverage. J Food Sci. Technol. 1985; 22(1):27-30.

Markam Shikha and Tigga Ravindra. 2021. Value addition of Syzygum cumini L. (Jamun). The Pharma Innovation Journal. 10(11):2822-2824.

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Caparino O. A., Tang J., Nindo C. I., Sablani S. S., Powers J. R. and Fellman J. K. (2012). Effect of drying methods on the physical properties and microstructures of mango (Philippine 'Carabao' var.) powder. Journal of Food Engineering. 111:135-148.

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Bernaert N., Droogenbroeck B.V., Pamel E.V., Ruyck H.D. (2018). Innovative Refractance Window Drying Technology to keep Nutrient Value during Processing," in Journal of Trends in Food Science & Technology, 84:22-24.

Abul-Fadl M. M. and Ghanem T. H. (2011). Effect of Refractance-Window (RW) Drying Method on Quality Criteria of Produced Tomato Powder as Compared to the Convection Drying Method. World Applied Sciences Journal. 15 (7):953-965.

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12. Financial Implications (in Lakhs): Rs. 15.22 lakhs

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

S. No.	Staff Category	Man months	Cost
1.	Scientific	10	10,00,000
2.	Technical	2	50,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	12	15,00,000

12.2 Research/Recurring Contingency

S. No.	Item	Year(1)	Year (2)	Total
2.	Consumables	10000	--	10000
3.	Travel	5000	--	5000
4.	Field Preparation/ Planting/ Harvesting (Man-days/costs)	--	--	--
5.	Inter-cultivation & Dressing (Man-days/costs)	--	--	--
6.	Animal/Green house/Computer Systems/Machinery Maintenance	2000	--	2000
7.	Miscellaneous(Other costs)	5000	--	5000
	Total(Recurring)	22000	--	22000

Justification: For purchase of raw materials, chemical etc.

12.3 Non-recurring (Equipment)

S. No.	Item	Year (1)	Year (2)	Total
1.		--	--	--
2.		--	--	--
	Total (Non-recurring)	--	--	--

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

12.4 Any Other Special Facility required (including cost)

12.5 Grand Total (12.1 to 12.4)

Item	Year (1)	Year (2)	Total
Grand Total	15,22,000	--	15,22,000

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

(iv) Name of Financing Organization : NA

(v) Total Budget of the Project :

(vi) 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				

13. Expected Output: Process will be standardised for value addition of jamun fruit.

14. Expected Benefits and Economic Impact

- Value addition of jamun fruit will be available.
- The new product will be available with the refractance window dryer.
- Farmers will get more price due to value addition of jamun fruit

8. Risk Analysis

9. Signature

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

10. Signature of HoD

11. 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: Development of jamun leather using refractance window dryer.
2. Date of Start & Duration: Date of Start: 01-01-'25 Likely Date of Completion: 31-03-'26
3. Institute Project [√] or Externally Funded [ ]
4. Estimated Cost of the Project : 15.22 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/2022/01	10%	01/12/2022	-	
				PH/JU/2024/01	15%	01/03/2022	-	

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 PME CELL OF RPP-I

(Refer for Guidelines ANNEXURE-XI (D))

1. Institute Name: Junagadh Agricultural University
2. Project Title: Development of jamun leather using refractance window dryer.
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 INVESTIGATION – 2
(To be presented in 40th Annual Workshop)

RPP - 1

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 : Extraction of bioactive compounds from castor leaves to check the effect against the *Malassezia* spp.
3. Type of research project: Basic/~~Applied/Extension/Farmer Participatory/Other~~ (specify)
4. Genesis and rationale of the project :

Castor (*Ricinus communis*) being most valuable oilseed crop in world, is a low priced commodity which is rich in oil percentage. India has good performance in production of castor seeds and oils i.e. 0.36 lakh tonne and 0.10 respectively lakh tonne (2020-21). With high production of oilseeds and oils, India exported the castor oil 734.34 ('000 tonnes) and earn Rs. 6801.99 crore in 2020-21. (Agricultural Statistics at a Glance - 2022).

In India, the major castor producing states are Andhra Pradesh, Gujarat, Karnataka, Odisha, Rajasthan and Tamil Nadu. Gujarat is the India's largest producer of castor in India, accounting for about 85.09 per cent in total production of castor in the country (2019-20). The productivity of castor in Gujarat is the highest not only in India but also in the World. Area, production and yield of castor in Gujarat is 650.27 thousand hectare, 1401.33 thousand tonne and 2155 kg./hectare respectively in 2021-22. Gujarat also played a vital role in Indian economy in export of castor oil. (Ministry of Agriculture and Farmers Welfare Department of Agriculture and Farmers Welfare, Government of India**).**

Plant kingdoms are the rich source of organic compounds, many of which have been used for medicinal purposes. There are many natural crude drugs from plants that have the potential to treat many disease and disorders and one of them is *Ricinus communis* (Chanda et al. 2010 and Begum D. et al., 2000). *Ricinus communis* is a species of flowering plant in the family, *Euphorbiaceae*. The parts of the plants used for medicinal purposes are the leaves, root, stem, fruits, complete aerial parts, the whole plant and flowers (Rana M. et al.,2012). The plant is reported to contain antioxidant properties in its methanolic leaf extract (Rao N. et al., 2013 and Gupta et al., 2007) anti-inflammatory activity (Saini et al., 2010), anti-diabetic activity (Shokeen K. et al., 2008) and antibacterial activity (Rao N. et al., 2013). The plant has hepatoprotective effect (Shukla B. et al., 1992) and has been used in the treatment of skin cancer (Prakash E. et al., 2014).

Ricinus communis has proven to possess antimicrobial activities as they were used against dermatophytic and pathogenic bacterial strains *S. aureus, P. aeruginosa* as well as *K. pneumoniae* and *E. coli* (Jena J. et al., 2012). Also, anti-fungal activity of the

leaf was potent against *Candida albicans* (Khan J. et al., 2011). The *Ricinus communis* possess wound healing activity due to the active constituent of castor oil which produce antioxidant activity and inhibit lipid peroxidation (Ciulei I. et al., 1982). The leaves of *R. communis* are believed to be used in the form of a poultice or fomentation on sores, boils and swellings (Rana M. et al.,2012).

Malassezia spp. are normally found in areas rich in sebaceous glands as they are lipid dependent. The genus *Malassezia* belongs to the basidiomycetous yeasts and is classified in the *Malasseziales* (Ustilaginomycetes, Basidiomycota) (Kurtzman et al.1998 and Boekhout et al., 2003). Fungi in the genus *Malassezia* are ubiquitous skin residents of humans and other warm-blooded animals. *Malassezia* are involved in disorders including dandruff and seborrheic dermatitis, which together affect >50% of humans (Xu J. et al., 2007).

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

Generally, the sowing of the castor crop is the month of august and farmers can remove the crop in a season of summer as per the crop conditions. The castor seeds are mainly used for the oil extraction but the castor leaves do not have any use after removal of the crops from the farm.

Dandruff is a chronic scalp condition characterized by visible flakes induced by rapid turnover of scalp cells. In general, dandruff occurs after puberty and mainly affects males more than the females (Shimer A. et al., 2000). Dandruff results from at least three etiologic factors: *Malassezia* fungi, sebaceous secretions, and individual sensitivity (DeAngelis YM et al., 2005 and Ro BI et al., 2005). *Malassezia* spp are involved in the etiology of pityriasis versicolor folliculitis, sebborrhoeic dermatitis and dandruff (Gueho E. et al., 1996 and Chang HJ et al., 1998).

An FMCG product, Hair Cleaning Shampoo is probably the largest unit of among the hair care products. The shampoo sector Since the shampoos are one of the cosmetic product used in daily as the hair is special and cherished feature of humans. It clears dirt, dandruff, promotes hair growth, luster , strengthens and darkens the hair. Majority of ingredients in the shampoos are chemicals and hence have been under severe attack due to its potential risk of side effects with its usage. The main objective of this project is to study how to eliminate harmful synthetic ingredients from anti-dandruff shampoo formulation and substitute them with safe natural ingredients. (Sravanthi K. et al., 2021)

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

- Cherish I. A. et al (2014) studied about the flavonoids and tannins present in various parts of Castor plant (*Ricinus communis* L.). They extracted it and analyzed the distribution and biological activities of flavonoids and tannins in various parts of Castor plant. Inhibition zone was observed in test organisms *Streptococcus aureus* and *Krebsellia halize* against the flavonoids and tannins at increasing concentrations (1 mg/ml, 5 mg/ml and 10 mg/ml) of different parts of extracts. It was concluded that the castor plant parts which are used for the

treatment of several ailments in many natives of the world making more beneficial through extraction of flavonoids and tannins.

- Gueho E. et al (1996) written in his article review about the pathogenicity of *Malassezia* spp., their distributions in dermatological conditions and in healthy skin. In the study, *Malassezia* yeasts have been classified into 14 species, among which eight have been isolated from human skin, including *Malassezia furfur, Malassezia pachydermatis, Malassezia sympodialis, Malassezia slooffiae, Malassezia globosa, Malassezia obtusa, Malassezia restricta, Malassezia dermatis, Malassezia japonica*, and *Malassezia yamatoensis*. In this study it was illustrated that yeasts do not invade the skin but act as the trigger factors to increase the sensitivity of the skin or induce the other organisms to play pathogenic roles. Some diseases like *Pityriasis versicolor, Malassezia folliculitis, Seborrheic dermatitis* etc. are the dermatological disorders and even systemic infections.
- Jennifer S. et al (2017) compared and analysed the bioactive compounds of *Ricinus communis* leaves which was extracted through aqueous, methanol, petroleum ether, ethyl acetate and ethanol. The research was focused on inhibitory effects of the respective extracts on *E. coli*, *S. aureus*, *P. aeruginosa*, *K. pneumonaie* and *C. albicans*. It was concluded in the study that all solvents extracts exhibited inhibitory activity against the growth of all microorganisms. The methanol extract showed highest zones of inhibition compared to other solvents extracts. All solvents extracts exhibited both bacteriostatic and bactericidal effects on the test organisms at varying concentration, with minimum inhibitory concentration *(*MIC) values ranging from 3.13 to 25.0 mg/ml and minimum funcidal concentration (MFC) of *C. albicans* was between 200 and 400 mg/l.
- Ro B.I. et al (2005) presented that a strong correlation with sebaceous gland (SG) activity and *Malassezia* population. When the sebaceous gland activity increases, the present but low *Malassezia* population has a new food source and proliferates, resulting in the scalp itching and flaking common to greater than 50% of adults. The pathogenic role of *Malassezia* in Dandruff and seborrheic dermatitis (D/SD) has been elucidated, and is focused on their lipid metabolism. *Malassezia restricta* and *M. globosa* require lipids. They degrade sebum, free fatty acids from triglycerides, consume specific saturated fatty acids, and leave behind the unsaturates. Penetration of the modified sebaceous secretions results in inflammation, irritation, and scalp flaking.

References :

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7. Expertise available with the investigating group/Institute

The PI & Co-PIs of project having enough experience of working in the field of Processing and Food Engineering. Experts in the field of Processing and Food Engineering. Assistant Biochemist is available from Dept. of Biochemistry & Biotechnology, JAU, Junagadh.

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

- The process technology for the extraction of leaf extracts of castor will be useful against the dandruff.
- The process technology can be made available to the commercial players and food processors.
- A green technology of will be availed to the society.

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

i. Castor growers
ii. Castor processors
iii. 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 : Extraction of bioactive compounds from castor leaves to check the effect against the *Malassezia* spp.
3. Key Words : Anti dandruff properties, Castor leaves, Fungi : *Malassezia* (Yeast)
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 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 Assistant Microbiologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	PI	60%	• Review collection / literature survey. • Collection of castor leaves. • Preliminary trial for extractions of anti-fungal nutrients with the help of aqueous, methanol, chloroform and petroleum ether from castor leaves. • Collect the fungal cultures from MTCC, Chandigarh and take a Preliminary trial. • Preliminary trials to see inhibition zone of extracted nutrients against the fungi:yeast. • Perform the optimized treatments as a final experiments. • Data collection and its analysis. • Report writing.

2.	Dr. P. J. Rathod Assistant Biochemist, Dept. of Bio-Technology, JAU, Junagadh	Co-PI-I	15%	To assist the PI to carry out biochemical analysis of the product
3.	Prof. D. V. Khanpara Assistant Entomologist, AICRP on PHET, Dept. of Processing and Food Engg., College of Agril. Engg. & Tech., Junagadh Agril. University, Junagadh	Co-PI-II	15%	3. To assist the PI in statistical analysis.
4.	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-III	10%	To assist the PI in taking administrative approvals as and when needed to carry out the different project related activities

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: 01-01-2025
Likely Date of Completion **:** 31-09-2026
9. (a) Objectives :

- To characterize the physico-chemical properties of castor leaf extracts and optimize the process parameters for the extraction of the bioactive compounds.
- To check the bio active compounds against the *Malassezia* yeast.

(b) Practical utility :

- The process technology for the extraction of bioactive compounds will be standardized.
- The process technology can be made available to the commercial players and food processors.
- A green technology will be availed to the society.

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.	Review collection	January - 25	March - 25	1. To collect the data on extraction of bioactive compounds from castor leaves. 2. To study the work done in the past.	100%	--	Prof. A. M. Joshi
2.	Procurement and Quality analysis of proposed product raw material.	April – 25	June - 25	Procurement of castor leaves and fungal cultures. Quality will be analysed.	100%	--	- Prof. A. M. Joshi - Dr. M. N. Dabhi
3.	Preliminary laboratory trials	July -25	Dec - 25	Preliminary trial run for fungal growth, bioactive compounds extraction through different methods, analysis of bioactive compounds will be carried out.	100%	--	- Prof. A. M. Joshi, - Dr. P. J. Rathod
4.	Extraction of bioactive compounds as per the final treatments.	Jan - 26	March - 26	Final treatment trials and quality analysis will be carried out.	--	100 %	- Prof. A. M. Joshi, - Dr. P. J. Rathod
5.	Quality analysis of bioactive compounds.	April - 26	June – 26	Bioactive compounds will be analyzed for its physical, biochemical and functional quality.	--	100 %	- Dr. P. J. Rathod - Prof. A. M. Joshi

6.	Data analysis and report writing	July -26	Sept -26	Compilation of collected data and preparation of report	--	100 %	- Prof. A. M. Joshi, - Dr. D. V. Khanpara, - Dr. M. N. Dabhi

2025												2026								
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Review collection																				
			Procurement and Quality analysis of proposed product materials																	
						Preliminary laboratory trials														
												Extraction of bioactive compounds as per the final treatments.								
															Quality analysis of bioactive compounds.					
																		Data analysis and report writing.		

11. Technical Programme (brief)

Justification :

Generally, the sowing of the castor crop is the month of august and farmers can remove the crop in a season of summer as per the crop conditions. The castorseeds are mainly used for the oil extraction but the castor leaves do not have any use after after removal of the crops from the farm.

Ricinus communis has proven to possess antimicrobial activities as they were used against dermatophytic and pathogenic bacterial strains *S. aureus, P. aeruginosa* as well as *K. pneumoniae* and *E. coli* (Jena J. et al., 2012). Also, anti-fungal activity of the leaf was potent against *Candida albicans* (Khan J. et al., 2011). The *Ricinus communis* possess wound healing activity due to the active constituent of castor oil which produce antioxidant activity and inhibit lipid peroxidation (Ciulei I. et al., 1982). The leaves of

R. communis are believed to be used in the form of a poultice or fomentation on sores, boils and swellings (Rana M. et al.,2012).

Dandruff is a chronic scalp condition characterized by visible flakes induced by rapid turnover of scalp cells. In general, dandruff occurs after puberty and mainly affects males more than the females (Shimer A. et al., 2000).Dandruff results from at least three etiologic factors: *Malassezia* fungi, sebaceous secretions, and individual sensitivity (DeAngelis YM et al., 2005 and Ro BI et al., 2005). *Malassezia*spp are involved in the etiology of pityriasis versicolor folliculitis, sebborrhoeic dermatitis and dandruff (Gueho E. et al., 1996 and Chang HJ et al., 1998).

They are normally found in areas rich in sebaceous glands as they are lipid dependent. The genus *Malassezia* belongs to the basidiomycetous yeasts and is classified in the *Malasseziales* (Ustilaginomycetes, Basidiomycota) (Kurtzman et al.1998 and Boekhout et al., 2003). Fungi in the genus *Malassezia* are ubiquitous skin residents of humans and other warm-blooded animals. *Malassezia* are involved in disorders including dandruff and seborrheic dermatitis, which together affect >50% of humans (Xu J. et al., 2007).

An FMCG product, Hair Cleaning Shampoo is probably the largest unit of among the hair care products. The shampoo sector Since the shampoos are one of the cosmetic product used in daily as the hair is special and cherished feature of humans. It clears dirt, dandruff, promotes hair growth, luster , strengthens and darkens the hair. Majority of ingredients in the shampoos are chemicals and hence have been under severe attack due to its potential risk of side effects with its usage. The main objective of this project is to study how to eliminate harmful synthetic ingredients from anti-dandruff shampoo formulation and substitute them with safe natural ingredients. (Sravanthi K. et al., 2021)

Status (review) :

- Cherish I. A. et al (2014) studied about the flavonoids and tannins present in various parts of Castor plant (*Ricinus communis* L.). They extracted it and analyzed the distribution and biological activities of flavonoids and tannins in various parts of Castor plant. Inhibition zone was observed in test organisms *Streptococcus aureus* and *Krebsellia halize against the* flavonoids and tannins at increasing concentrations (1 mg/ml, 5 mg/ml and 10 mg/ml) of different parts of extracts. And it was concluded that the castor plant parts which are used for the treatment of several ailments in many natives of the world making more beneficial through extraction of flavonoids and tannins.
- Gueho E. et al (1996) written in his article review about the pathogenicity of Malassezia spp., their distributions in dermatological conditions and in healthy skin. In the study, Malassezia yeasts have been classified into 14 species, among which eight have been isolated from human skin, including *Malassezia furfur, Malassezia pachydermatis, Malassezia sympodialis, Malassezia slooffiae, Malassezia globosa, Malassezia obtusa, Malassezia restricta, Malassezia dermatis, Malassezia japonica,* and *Malassezia yamatoensis*. In this study it was illustrated that yeasts do not invade the skin but act as the trigger factors to increase the sensitivity of the skin or induce the other organisms to to play pathogenic roles. Some diseases like Pityriasis versicolor, Malassezia

folliculitis, Seborrheic dermatitis etc. are the dermatological disorders and even systemic infections.

- Jennifer S. et al (2017) compared and analysed the bioactive compounds of *Ricinus communis* leaves which was extracted through aqueous, methanol, petroleum ether, ethyl acetate and ethanol. The research was focused on inhibitory effects of the respective extracts on *E. coli, S. aureus, P. aeruginosa, K. pneumonaie* and *C. albicans*. It was concluded in the study that all solvents extracts exhibited inhibitory activity against the growth of all microorganisms. The methanol extract showed highest zones of inhibition compared to other solvents extracts. All solvents extracts exhibited both bacteriostatic and bactericidal effects on the test organisms at varying concentration, with minimum inhibitory concentration *(*MIC) values ranging from 3.13 to 25.0 mg/ml and minimum funcidal concentration (MFC) of *C. albicans* was between 200 and 400 mg/l.
- Ro B.I. et al (2005) presented that a strong correlation with sebaceous gland (SG) activity and *Malassezia* population. When the sebaceous gland activity increases, the present but low *Malassezia* population has a new food source and proliferates, resulting in the scalp itching and flaking common to greater than 50% of adults. The pathogenic role of *Malassezia* in Dandruff and seborrheic dermatitis (D/SD) has been elucidated, and is focused on their lipid metabolism. *Malassezia restricta* and *M. globosa* require lipids. They degrade sebum, free fatty acids from triglycerides, consume specific saturated fatty acids, and leave behind the unsaturates. Penetration of the modified sebaceous secretions results in inflammation, irritation, and scalp flaking.

Objectives:

- To characterize the physico-chemical properties of castor leaf extracts and optimize the process parameters for the extraction of the bioactive compounds.
- To check the bio active compounds against the *Malassezia* yeast.

Technical programme

8. Experimental Detail :

(a)	Design : FCRD	(d)	Base material : Powder of Castor (*Ricinus communis*) leaves. (Mesh size 60)
(b)	Replication : 3	(e)	Fungal : Yeast cultures : *Malassezia spp.*
(c)	Treatment : 8	(f)	Treatment parameters : 1. Extraction Medium : E_1 = Distilled Water, E_2 = Methanol, E_3 = Chloroform, E4 = Petroleum ether 2. Variety of plant : V_1 = GCH – 6 , V_2 = GCH - 7

Treatment No.	Treatment Combination	Extraction Medium	(Powder of Plant Variety)
T1	E_1V_1	Distilled Water	GCH – 6
T2	E_2V_1	Methanol	GCH – 6
T3	E_3V_1	Chloroform	GCH – 6
T4	E_4V_1	Petroleum ether	GCH – 6
T5	E_1V_2	Distilled Water	GCH – 7
T6	E_2V_2	Methanol	GCH – 7
T7	E_3V_2	Chloroform	GCH – 7
T8	E_4V_2	Petroleum ether	GCH – 7

(h) Observations :

(i) Extraction of bioactive compounds from castor leaves.

(ii) To check the bioactive compounds against the *Malassezia spp.*

- **Methodology :**

Collection of *Ricinus communis* leaves

Dry the leaves under the shed

Ground the powder and passed through 60 mesh

Soacked the 50 g powder in 500 ml extraction medium

The powder-solvent solutions were stirred at 35°C for 4 hours using a shaking incubator at a speed of 100 rpm

Extracts were then filtered with Whatman no. 1 filter paper

The filtrates were evaporated under a vacuum till dryness using a rotary evaporator

Concentrated to dryness in rotary evaporator under reduced pressure

1. Qualitative Analysis of the bioactive compounds.
2. Check the inhibitory action of bioactive comounds against the *Malassezia spp.* yeast

Process flow chart for extraction of bioactive compounds from castor leaves

<u>Possible outputs</u>:

- The process technology for the extraction of bioactive compounds of leaf extracts of castor will be useful against the dandruff.
- The process technology can be made available to the commercial players and food processors.
- A green technology of will be availed to the society.

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12. Financial Implications (in Lakhs) : Rs. 39.32 lakhs

(A) Financed by the institute

12.1 Manpower (Salaries / Wages)

S. No.	Staff Category	Man months	Cost
1.	Scientific	23	35,00,000
2.	Technical	5	4,00,000
3.	Supporting	--	--
4.	SRFs/RAs	--	--
5.	Contractual	--	--
	Total	28	39,00,000

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: Purchase of chemicals and others

12.3 Non-recurring (Equipment)

S. No.	Item	Year (1)	Year (2)	Year (3)	Total
1.	Rotary Evaporator	50,000/-	--	--	50,000/-
2.	--	--	--	--	--
	Total (Non-recurring)	50,000/-	--	--	50,000/-

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	20,50,000	19,32,000	--	39,82,000

(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				

ANNEXURE - III

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

1. Project Title : Extraction of bioactive compounds from castor leaves to check the effect against the *Malassezia* spp.

2. Date of Start & Duration : January – 2025 to September - 2026

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

4. Estimated Cost of the Project : 39,82,000/- 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
				PH/JU/2022/01	15%	01/12/2022	-	PH/JU/2022/01	10%	01/12/2022	-
								PH/JU/2024/01	25	01-03-2024	

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–III

HOD/PD/I/c

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

1. Institute Name : AICRP on PHET, JAU, Junagadh
2. Project Title : Extraction of bioactive compounds from castor leaves to check the effect against the *Malassezia* spp.
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

SUMMARY OF PROGRESS REPORT

1. PH/JU/85/1 : Operational research project on Agro Processing Centres.

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 2024-25. All the installment of Loej and Virol are deposited and the equipments purchased for them are given for permanent and now there is no due for payments. The equipment from our store register are removed and they have listed in their store register.

2. PH/JU/2024/01 : Development of Protein Enriched Ready-to-Eat Extruded Product ideal for Fasting by Supplementing Defatted Peanut Flour.

Fasting is an ancient practice with both healing and spiritual significance, observed for thousands of years across various cultures. In India, fasting plays a central role in many Hindu festivals, with specific foods consumed during these periods of ritual observance. Common ingredients for fasting foods include amaranth, barnyard millet, tapioca pearls, and peanuts, which are used to prepare a variety of dishes that cater to those observing the fast. Extruded snacks made from a combination of cereals and tubers are particularly popular across all age groups.

The present study aims to develop extruded snacks suitable for fasting by incorporating peanuts, amaranth, barnyard millet, and tapioca pearls as key ingredients. The formulation of a composite flour from these raw materials was optimized using a Mixture Design Response Surface Methodology (RSM) based on sensory evaluation. The final optimized blend was then used to determine the best processing conditions for producing extruded snacks suitable for fasting.

The study examined the effects of various processing parameters, including feed moisture content (12%, 13%, 15%, 17%, 18%), die head temperature (90°C, 102°C, 120°C, 138°C, 150°C), and screw speed (200 rpm, 220 rpm, 250 rpm, 280 rpm, 300 rpm) on the machine and physicochemical properties of the extruded product. The optimal processing conditions were found to be a die temperature of 131.73°C, a screw speed of 255.19 rpm, and a feed moisture content of 14.43%. Under these conditions, it would be possible to produce an extruded product with torque of 21.17 Nm, mass flow rate of 222.97 g/min, bulk density of 0.050 g/cm3, expansion ratio of 4.31, moisture content of 8.68%, carbohydrate of 67.79%, protein of 16.24%, WSI of 10.69% WAI of 4.50 (g/g), Hardness of 123.10 (N/m), crispness of 354.95, and overall acceptability of 7.55.

3. PH/JU/2023/1 : Management of Insect Pest of Storage Wheat in Bin by Ozone.

Fabrication of good quality G.I. metal cylindrical storage bins (100 kg capacity-20 nos.) were completed. The wheat purchase procedure was completed during from March to May - 2024. Initial observations on moisture per cent, pest infestation and germination were taken as per technical program. The wheat was filled in bins as per treatment and sealed air tightly. Then after, ozone treatment was started during month of June 2024. The treatments was given as per treatment schedule in each bin.

The data indicated that the initial percent germination was found 98.0 % to 99.0% and it was not found significant. After three month of storage, per cent germination also not found significant and it was ranged from 96.0 & to 98.5 % (Table 3.1).

The percent moisture content of grain was found 6.40 % to 6.83 % at initial time of trial and it was found non-significant. (Table 3.2). The results showed that the insect infestation was not observed up to 90 days after installation of trial in all the treatments (Table 3.3).

The trial is continue.

Action Taken of proceeding of 39th Annual Workshop.

Sr. No.	Project	Comment	Action Taken
1.	Development of protein enriched Ready-to-Eat extruded product ideal for fasting by supplementing defatted peanut flour.	• Collaborate with industry for funding. • Address the issues of aflatoxins in defatted peanut cake. • Approved as adaptive trial for one year.	• One industry named as Shreenathji Proteins, Rajkot, Gujarat has been approached in this regard. We procured the raw material (defatted peanut flour) from them. • Aflatoxin were checked in the defatted peanut as and when extruded product is prepared. • Work is completed and RPP-III has prepared and submitted.
2.	Development of millet based extruded product supplemented with defatted peanut flour.	• Junagadh has major area in castor, a project on castor should be should be submitted for nutraceutical extraction in place of this project in mid-term review.	Suggesstions implemented • In mid-term review meeting, a new project on extraction of protein from deoiled castorseed cake was put. • In 40th workshop, total three projects will be presented and out of these, two new projects on castor crop.
3.	Standardization of process technology for preparation of peanut sauce and peanut wadi (Chunks).	• Prepare complete documentation of peanut sauce technology. • Close the preparation of peanut wadi technology as the hypothesis proved wrong.	• Preparation of the documentation is completed and will be submitted to PC office. • Applied for the grant of Patent. Patent Proforma submitted to PC office for further necessary action. • Project on preparation of peanut wadi is discontinued due to unavailability of the suitable machinery with the center as well as in the nearby area/industry.

Tentative technical programme for the year 2024-25

Sr. No.	Code No.	Project 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/2023/1	Management of Insect Pest of Storage Wheat in Bin by Ozone.
3.	New Investigation - I	Development of Jamun Leather using Refractance Window Dryer.
4.	New Investigation - II	Protein Extraction from Deoiled Castor Seeds Cake through Microbial Intervention.
5.	New Investigation - III	Extraction of bioactive compounds from castor leaves to check effect against the *Malassezia* spp.

PATENTS

Sr. No.	Tittle of Patent/Design	Whether PC Unit was informed
1.	Peanut sauce production through acid hydrolysis.	Patent proforma provided by PC office is filled and submitted to PC office for patent application
2.	Peanut sauce production technology (Fermentation Method)	

PUBLICATION, TRAINING AND DEMONSTRATION

Research/ Review/Status Paper (NAAS rated only)

1. Devanand Gojiya, Vanraj Gohil, Mukesh Dabhi, Navnitkumar Dhamsaniya. 2024. Storage stability of jaggery based sesame spread- A comprehensive study. Journal of Stored Products Research. 107. https://doi.org/10.1016/j.jspr.2024.102350. May 2024. NAAS 8.70 2024.
2. Ravina G. Parmar and Mukesh N. Dabhi. 2024. Effect of blanching time, slice thickness and drying temperature on antioxidant activity and curcumin content of turmeric rhizome (Var. Salem). International Journal of Innovative Horticulture. 13(1):81-88. May 2024. NAAS 4.02 2024.
3. M. N. Dabhi, R. D. Dhudashia. 2024. Effect of packaging material on infestation level in stored groundnut pods. Journal of Agricultural Engineering (India) 61(4):509-524.
4. Vaibhav Vyas, Paresh Davara, Ashish Joshi, Mukesh Dabhi, Pankajkumar Rathod, Parthkumar Sapariya. 2024. Physical and sensory properties of peanut sauce prepared through fermentation process, The Pharma Innovation, 12(5):2620-2625.
5. Dhruv Chocha, PR Davara, VP Sangani, Vidhya V and Poornima Diwate. 2024. Physical and machine parameters of extruded products prepared from pearl millet flour blended with defatted peanut flour, International Journal of Advanced Biochemistry Research, 8(7):799-814.

Popular Articles/Technical Bulletins/Leaflets

1. P. R. Davara, V. P. Sangani, G. D. Gohil. 2024. Soybean: The Premier Protein Source for Bakery Products, Agriculture & Food: e-Newsletter, Vol. 6, Issue 2, Feb-2024.
2. Kher Rohitkumar, A. M. Joshi, Chiragkumar V.M. ટામેટાના સુક્ષ્મ જીવો સામે ઓઝોનાઈઝેશનની અસર. Krushi Prabhat. p.23. March-2024.

Extensions and Outreach Activities (Training Kisan Melas, FLD, EDP etc.)

Machinery and Technology Demonstration Mela was organized at Junagadh Centre by ICAR-AICRPs at Junagadh Centre on dated 14/03/2024. About 1100 farmers were participated in this demonstration mela.


Inauguration of Demonstration Mela

Address by Dr. V. P. Chovatiya, Hon. Vice Chancellor, JAU, Junagadh.




Farmers Participation and Demonstration of machineries in Mela

Plate Ex. Act. 1 : Photographs of Machinery and Technology Demonstration Mela

DEMONSTRATION of "Industry Meet cum Showcase of Developed Process Technologies" of ICAR-AICRP on PHET, JAU, Junagadh Center.

ICAR-AICRP on PHET, JAU, Junagadh center has organized an "Industry meet cum showcase of developed process technologies" on 16th October, 2024.

22 Industry persons, FPO and others have participated. Process Technology and processing machinery developed has been presented. Industry persons have taken interest to work in PPP mode for process technology. Continuous microwave dryer, onion storage technology, onion curing technology, pigeon pea process, etc. have attracted to the participants. Extruded products developed by JAU were showcased and also live demonstrations was carried out for the benefit of the participants.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Inauguration of Programme by Director of Extension Education, JAU, Junagadh</td><td>Presentation of Developed Technology</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Presentation of Developed Technology</td><td>Demonstration of Extruder</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Demonstration of making Extruded Products</td><td>Developed Extruded Products</td></tr>
<tr><td colspan="2">Plate Ex. Act. 2 : Photographs of Industry Meet cum Showcase of Developed Process Technologies" of ICAR-AICRP on PHET</td></tr>
</table>

Other Activities : Awareness Programmes

1. **International Day of Awareness of Food Loss and Waste. Date : 11th October, 2024**
   Faculty and UG and PG students have been participated. PG students have been given task to visit the Industries, APMC and Storage godowns to observe the loss and waste.

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Welcome Address by Dr. M. N. Dabhi, Research Engineer, AICRP on PHET</td><td>Participation of Faculty and UG-PG Students in a programme</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Presentation and Question-Answer session after Food loss and waste survey</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Presentation and Question-Answer session</td><td>Certificate Distribution</td></tr>
<tr><td colspan="2">Plate Awareness Act. 1 : Photographs of Celebration of International Day of Awareness of Food Loss and Waste.</td></tr>
</table>

2. **World Food Day. Date : 11th October, 2024.**

Faculty and UG and PG students have participated. Seven UG students have participated in elocution. Prize distributed to the first and second rank students.

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<tr><td>  </td><td>  </td></tr>
<tr><td>Welcome Address by Dr. M.N.Dabhi, R.E.</td><td>Participaiton of Staff and Students</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Participaiton of Staff and Students</td><td>Feedback of students</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Feedback of students</td><td>Prize and Certificate Distribution</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td colspan="2">Prize and Certificate Distribution</td></tr>
<tr><td colspan="2">Plate Awareness Act. 2: Photographs of Celebration of World Food Day.</td></tr>
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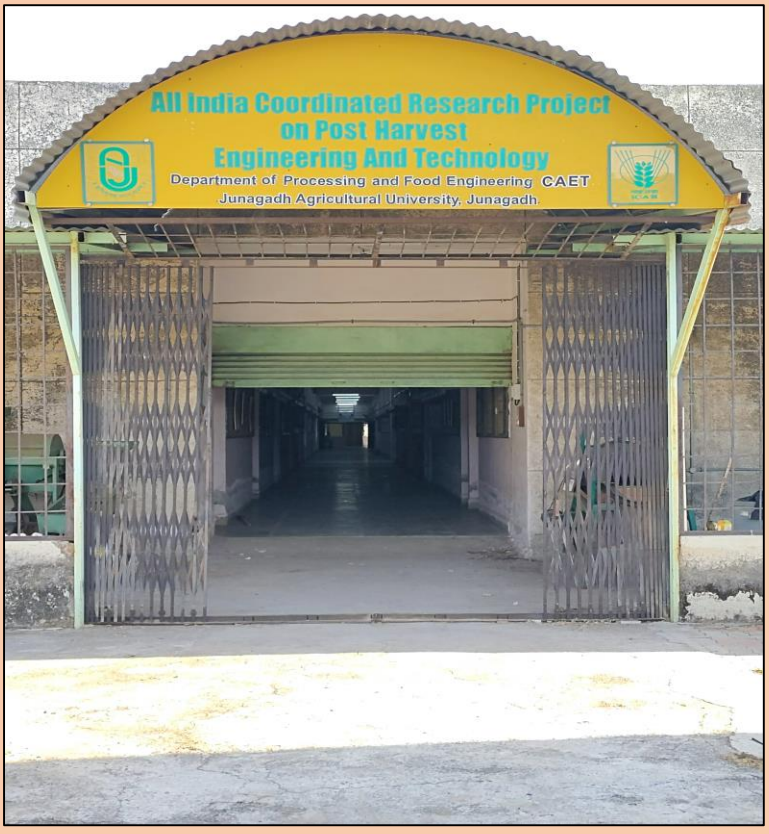
WEL-COME


All India Coordinated Research Project
on Post Harvest
Engineering And Technology
Department of Processing and Food Engineering CAET
Junagadh Agricultural University, Junagadh