To study sensory quality and production cost of Khoa Modak blended with Jaggery and Pumpkin seeds

Abstract

The present investigation entitles "Evaluation of Khoa Modak blended with Jaggery and Pumpkin (*Cucurbita Pepo* L.) seeds" was conducted at Dairy Science Laboratory of Department of Animal Husbandry and Dairy Science, College of Agriculture, Dr. BSKKV., Dapoli (M.S.) to incorporate Jaggery and Pumpkin seeds successfully in preparation of Khoa Modak. This study aimed to evaluate processed for manufacturing of Khoa Modak blended with Jaggery and Pumpkin (*Cucurbita pepo* L.) seeds and to study effect of different levels of Jaggery and Pumpkin seeds on sensory quality and production cost of Khoa Modak.In present study, blend of Jaggery and Pumpkin seeds was successfully used in preparation of Khoa Modak at four levels of Jaggery i.e., 12, 15, 18 and 21 (%) and Pumpkin seeds were added at two levels 5 and 7.5 (%), respectively. It was found that 18 (%) Jaggery and 7.5 (%) Pumpkin seeds was best treatment (J_3P_2) in present study. Khoa Modak with 18 (%) Jaggery and 7.5 (%) Pumpkin seeds had the highest overall acceptability score. The rigorous evaluation of the data indicates that of all the levels of Jaggery and Pumpkin seeds were significant ($p<0.01$) and had highest scored, the best product was obtained with 18 (%) Jaggery and 7.5 (%) Pumpkin seeds content. Hence, 18 (%) was chosen the most optimal level of Jaggery and 7.5 (%) of Pumpkin seeds for Khoa Modak preparation. At this quantity of Jaggery and Pumpkin seeds at 18 (%) and 7.5 (%) generated the highest quality product, with a score of treatment J_3P_2 (8.64). As a result, a reasonable level of Jaggery at 18 (%) and Pumpkin seeds at 7.5 (%) for producing the best quality Khoa Modak. The addition of Jaggery and Pumpkin seeds reduced the cost of producing Khoa Modak proportionally. The cost of Khoa Modak under treatments J_1P_1, J_1P_2, J_2P_1, J_2P_2, J_3P_1, J_3P_2, J_4P_1 and J_4P_2 was Rs. 331.62, Rs.337.23, Rs.327.08, Rs.332.65, Rs.322.76, Rs.328.28, Rs.318.65, Rs.324.12 per kg., respectively.

Key words:- Cow milk, Khoa, Khoa Modak, Jaggery, Pumpkin seeds.

Introduction:-

Milk is a highly nutritious liquid produced by the mammary glands of mammals. It is a primary source of nutrition for young mammals before they can digest solid food. The constituents of milk are water, fat, proteins, lactose and salts which are its main constituents and determine its nutritional and commercial value. Cow milk is a complete food, which covers almost all the needs of the human body. Precisely, it consists of proteins, lactose, triglycerides, phosphorus, calcium and vitamins (B_2, A and mainly D). It is rich in calcium and lysine, an amino acid that is often missing from plant proteins (Lambrini et al., 2020).

Khoa is a heat-desiccated Indian traditional dairy product made by continuously boiling milk until the necessary milk solids concentration (60-70 %) is achieved (Kumar et al. 2016). FSSAI (2011) requires a minimum of 30 (%) fat on dry matter, no added starch, sugar, or colouring and 0.1 (%) citric acid by weight.

India is the country with the highest production and consumption of Jaggery. More than 70 (%) of global manufacturing occurs in India. The major sugarcane producing states of India are Karnataka, Maharashtra, Tamil Nadu, Uttar Pradesh and Andhra Pradesh contributing to around 80-90 (%) of Jaggery production. Out of the 300 MT of sugarcane produced in India, 53 (%) is converted into white sugar, 3 (%) is used for cane juice, 36 (%) is processed into Jaggery and khandsari and 8 (%) is used as cane seed. India would need at least 54 MT of sweeteners, out of this about 40 (%) has to be met by Jaggery (Pravallika et al., 2018). Jaggery is high in minerals (calcium, magnesium, potassium, phosphorus, sodium, iron, manganese, zinc, copper and chloride) and vitamins (A, B_1, B_2, B_5, B_6, C and D_2). Jaggery contains micronutrients with antitoxic and anticarcinogenic effects. It contains moderate amounts of calcium, phosphorus and zinc (Shrivastav et al., 2016).

Pumpkin seeds are a locally available, underutilized and viable food source. These contain nutrients and therapeutic characteristics. Pumpkin seeds contain oil, protein, fibre and essential minerals. These seeds are a rich source of nutrients, including zinc, phosphorus, magnesium, potassium and selenium, which can help combat disorders like arthritis, inflammation, prostate cancer, etc. (Maheshwari et al., 2015).

Khoa Modak, a classic Indian sweet, is a popular confection composed mostly of khoa, a dairy product created by slowly boiling whole milk. Khoa Modak, known for its rich, creamy texture and pleasantly sweet flavor, is frequently formed into small, intricate molds that resemble traditional Modak, which is used as a symbolic offering during festivals such as Ganesh Chaturthi. Khoa Modak is made by meticulously reducing milk to remove the majority of its water content, resulting in a solid, nutrient-rich base that serves as the foundation for many Indian desserts. This ancient approach ensures that Khoa Modak is both delicious and high in critical elements including protein, calcium and vitamins.

Scope and Limitations

The study on the evaluation of Khoa Modak with Jaggery and Pumpkin seeds includes a thorough examination of its nutritional, sensory and economic aspects. The scope of modak includes modak is a traditional sweet in kokan region of Maharashtra, particularly during Ganesh Chaturthi. Evaluating how well a variation with khoa, jaggery, and pumpkin seeds is accepted by locals who are accustomed to more traditional fillings. Assessing the awareness and interest in

health-conscious foods among the local population, given the nutritional benefits of Pumpkin seeds (rich in protein, healthy fats, and micronutrients like iron and calcium.) and Jaggery (considered a healthier alternative to refined sugar). Sensory evaluation will be performed using consumers' taste to determine the acceptability of the modified modak in terms of taste, texture and overall satisfaction. The study will investigate the economic viability of making this novel confection, taking into account ingredients costs, manufacturing procedures and market potential. This research aims to provide valuable insights for dairy product manufacturers, nutritionists and local farmers by demonstrating the benefits of incorporating traditional and nutritious ingredients into popular sweets. This evaluation would provide a comprehensive understanding of how well Khoa Modak blended with jaggery and pumpkin seeds might perform in the Konkan region, considering cultural, market, nutritional, and economic perspectives. The demand for modak is highly seasonal, peaking during festivals like Ganesh Chaturthi. Evaluating the product outside this peak season might not provide a true picture of its market potential. Changes in the economy, such as inflation or fluctuations in the price of ingredients like Jaggery and Pumpkin seeds, can affect consumer purchasing power and willingness to try new 7 products. The general awareness and understanding of the nutritional benefits of ingredients like Pumpkin seeds might be limited among the local population. This could lead to underestimation of the product's appeal based on health benefits. The availability and consistent quality of Pumpkin seeds, which may not be a staple in the region, could be a limitation, affecting both production and consumer experience. Evaluating the feasibility of sourcing ingredients locally might be limited by supply chain complexities, especially in remote areas of the Konkan region. Evaluating the shelf life and storage requirements of the product, especially in the humid climate of the Konkan region, could be a limitation if not thoroughly tested

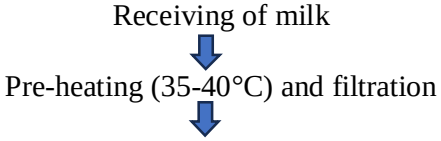
Material and method: -

All the material required was procured from local market and also facilities provided by Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli, Ratnagiri,(M.S) India.

Method Adopted

Preparation of Jaggery Modak:-Jaggery Modak was prepared in two steps

Flow chart for preparation of Khoa Modak blended with Jaggery and Pumpkin (*Cucurbita pepo* L.) seeds. Jaggery Modak was prepared as per procedure given by Gavhane et al. (2012) with slight modification.



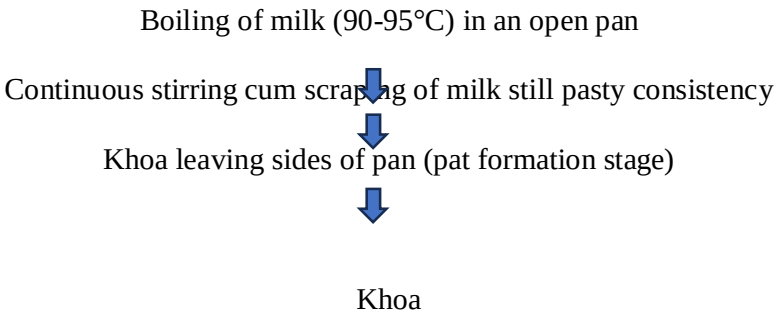


Fig 1:- Stept 1 for Preparation of Khoa

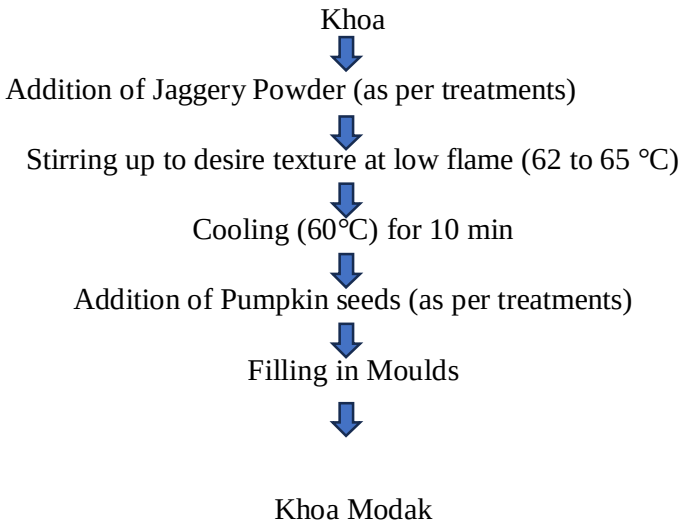


Fig 2 :-Step 2 for Preparation of Khoa Modak

3.2.1 Experimental Details

The experiment was conducted with Khoa blended with Jaggery and Pumpkin (*Cucurbita pepo* L.) seeds. There were four different levels of Jaggery and two levels of Pumpkin seeds were used on the basis of final weight of khoa obtain from milk.

3.2.2 Treatment Details

Table 1: List of Treatment Details

Treatments	Treatment Details
J_1P_1	100 (%) Khoa + 12 (%) Jaggery + 5 (%) Pumpkin seeds
J_1P_2	100 (%) Khoa + 12 (%) Jaggery + 7.5 (%) Pumpkin seeds
J_2P_1	100 (%) Khoa + 15 (%) Jaggery + 5 (%) Pumpkin seeds
J_2P_2	100 (%) Khoa + 15 (%) Jaggery + 7.5 (%) Pumpkin seeds
J_3P_1	100 (%) Khoa + 18 (%) Jaggery + 5 (%) Pumpkin seeds
J_3P_2	100 (%) Khoa + 18 (%) Jaggery + 7.5 (%) Pumpkin seeds
J_4P_1	100 (%) Khoa + 21 (%) Jaggery + 5 (%) Pumpkin seeds

J_4P_2	100 (%) Khoa + 21 (%) Jaggery + 7.5 (%) Pumpkin seeds

Sensory Evaluation

The product was been served to a panel of 8-10 semi trained judges for organoleptic evaluation. Sensory evaluation shall be carried out by adopting 9 points Hedonic scale method as per IS: 6273, Part-I (1971). The Khoa Modak was evaluated by the judges for sensory attributes like colour and appearance, body and texture, flavour and overall acceptability.

Cost of Production

The material/ingredients needed for the preparation of Khoa Modak blended with Jaggery and Pumpkin seeds were rated as per the current market rates (2023-24) and cost of production of Khoa Modak blended with Jaggery and Pumpkin seeds was worked out.

Statistical analysis: -

The experimental design was used for statistical analysis are Factorial Completely Randomized Design (FCRD) using eight treatments and five replications.

Results and Discussion

1 Sensory evaluation of Khoa Modak

1.1 Colour and appearance

The data pertaining to sensory score for colour and appearance at different treatments are given in Table 2 and Fig 1

Table 2 Effect of different levels of Jaggery and Pumpkin seeds on Colour and appearance of Khoa Modak (out of nine)

Levels of Pumpkin Seeds (%)	Levels of Jaggery (%)				Mean
	J_1 (12)	J_2 (15)	J_3 (18)	J_4 (21)	
P_1 (5)	7.42	7.75	8.22	7.98	**7.84**
P_2 (7.5)	7.59	7.92	8.27	8.11	**7.97**
Mean	**7.51**	**7.84**	**8.25**	**8.04**	**7.91**

Table 3: Results of ANOVA (Sensory evaluation)

SV	DF	SS	MSS	Cal F	Tab F (5%)	Tab F (1%)	Sig
Treatment	8	3.20	0.40	6.31	2.24	3.13	**S**
Jaggery	3	3.01	1.00	15.81	2.90	4.46	**S**
Pumpkin seeds	1	0.17	0.17	2.65	4.15	7.50	**NS**
Interaction	3	0.02	0.01	0.13	2.90	4.46	**NS**
Error	**32**	2.03	0.06	--	--	--	--
Total	39	--	--	--	--	--	--

Table 4: Correlation Table (Sensory evaluation)

Particulars	S.E.(M)	C.D. 1%	C.D. 5%	5%	1%
Jaggery	0.08	0.11	0.23	**S**	**S**
Pumpkin seeds	0.06	0.08	0.16	**NS**	**NS**
Interaction	**0.11**	**0.16**	**0.32**	**NS**	**NS**

The table for point 1.0 indicator that as the level of Jaggery goes on increasing there was increase in the score for colour up to 18 (%) inclusion. However, at 21 (%) level there was reduction in score. The colour of Jaggery is reddish so it has been observed that with the increasing level of Jaggery the product obtains faint reddish brown to deep reddish in colour which was accepted by judges. However, at 21 (%) inclusion the colour became dense reddish brown which was not accept much by judges and so there was reduction in score.

As regards to Pumpkin seed it does not have any specific colour. However, they are slightly off white in colour.

Results indicated that addition of 7.5 (%) Pumpkin seeds provided better results than addition of 5 (%) Pumpkin seeds addition it might be due to fact that off white colour of Pumpkin seed provided typical brightness to the product resulting in higher score.

The statistical examination of the data revealed no significant differences related to interaction of Jaggery and Pumpkin seeds. The inclusion of Jaggery significantly affect the difference in colour and appearance scores of Khoa Modak due to varied quantities of Jaggery. However, inclusion of Pumpkin seeds did non-significantly affect colour and appearance of Khoa Modak.

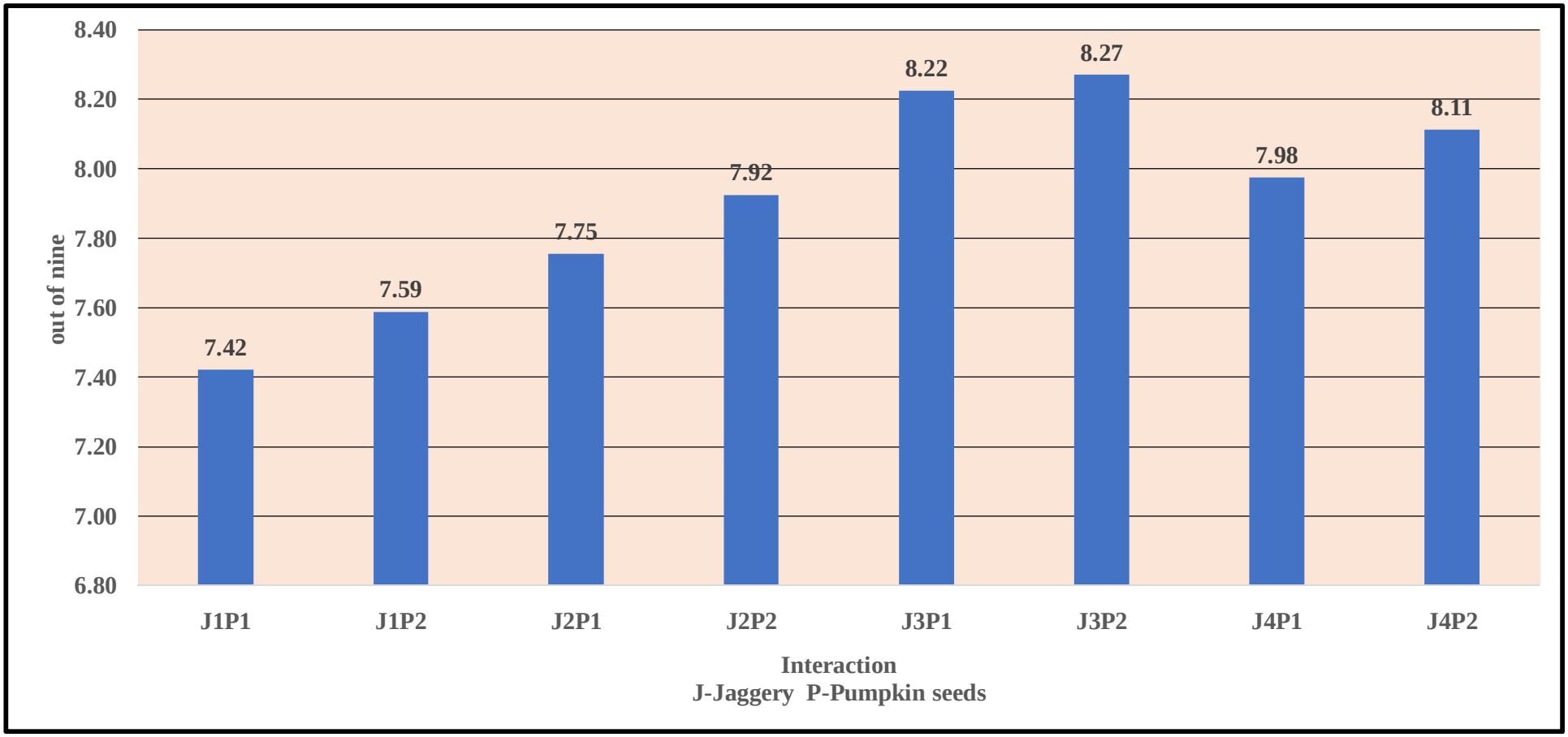


Fig 3 Effect of different levels of Jaggery and Pumpkin seeds on Colour and appearance of Khoa Modak (out of nine)

The present investigation is similar to findings of Chaudhari (2015) observed that, as the level of carrot pulp increased, the colour and appearance of burfi increases up to certain limit and thereafter it decreased score (18.55 to 15.18).

Hoshing et al. (2023) studies on sensory qualities of burfi prepared from cow milk Khoa and beetroot (*Beta vulgaris*) pulp. They observed as the level of beetroot pulp increases, the colour and appearance of burfi increases up to certain limit and thereafter it decreased score (8.70 to 6.90).

Body and texture

The data pertaining to sensory score for body and texture in respect of Khoa Modak are given in Table 5 and Fig 4.

Table 5 Effect of different levels of Jaggery and Pumpkin seeds on Body and Texture of Khoa Modak (out of nine)

Levels of Pumpkin seeds (%)	Levels of Jaggery (%)				Mean
	J_1 (12)	J_2 (15)	J_3 (18)	J_4 (21)	
P_1 (5)	7.03	7.16	7.71	8.00	**7.48**
P_2 (7.5)	7.10	7.37	7.80	8.09	**7.59**
Mean	**7.06**	**7.27**	**7.75**	**8.05**	**7.53**

Table 6: Results of ANOVA (Body and Texture)

SV	DF	SS	MSS	Cal F	Tab F (5%)	Tab F (1%)	Sig
Treatment	8	6.22	0.78	1.76	2.24	3.13	**NS**
Jaggery	3	6.06	2.02	4.58	2.90	4.46	**S**
Pumpkin seeds	1	0.13	0.13	0.30	4.15	7.50	**NS**
Interaction	3	0.03	0.01	0.03	2.90	4.46	**NS**
Error	**32**	14.11	**0.44**	--	--	--	--
Total	39	--	--	--	--	--	--

Table 7: Correlation Table (Body and texture)

Particulars	S.E.(M)	C.D. 1%	C.D. 5%	5%	1%
Jaggery	0.21	0.30	0.60	**S**	**S**
Pumpkin seeds	0.15	0.21	0.43	**NS**	**NS**
Interaction	**0.30**	**0.42**	**0.85**	**NS**	**NS**

Table 5 shows effect of different level of Jaggery and Pumpkin seeds on body and texture of Khoa Modak. Normal texture of Jaggery is granular which provided ideal texture expected from Khoa Modak so it has been observed that as the levels of Jaggery increased this was increased in the score for body and texture parameter. However, it has been found at 21 (%) was very marginal e.g. there was about 7-8 (%) increase in score when level of Jaggery increase from 15-18 per cent. However, when level was 21 (%) the increase in score was merely 3-4 per cent.

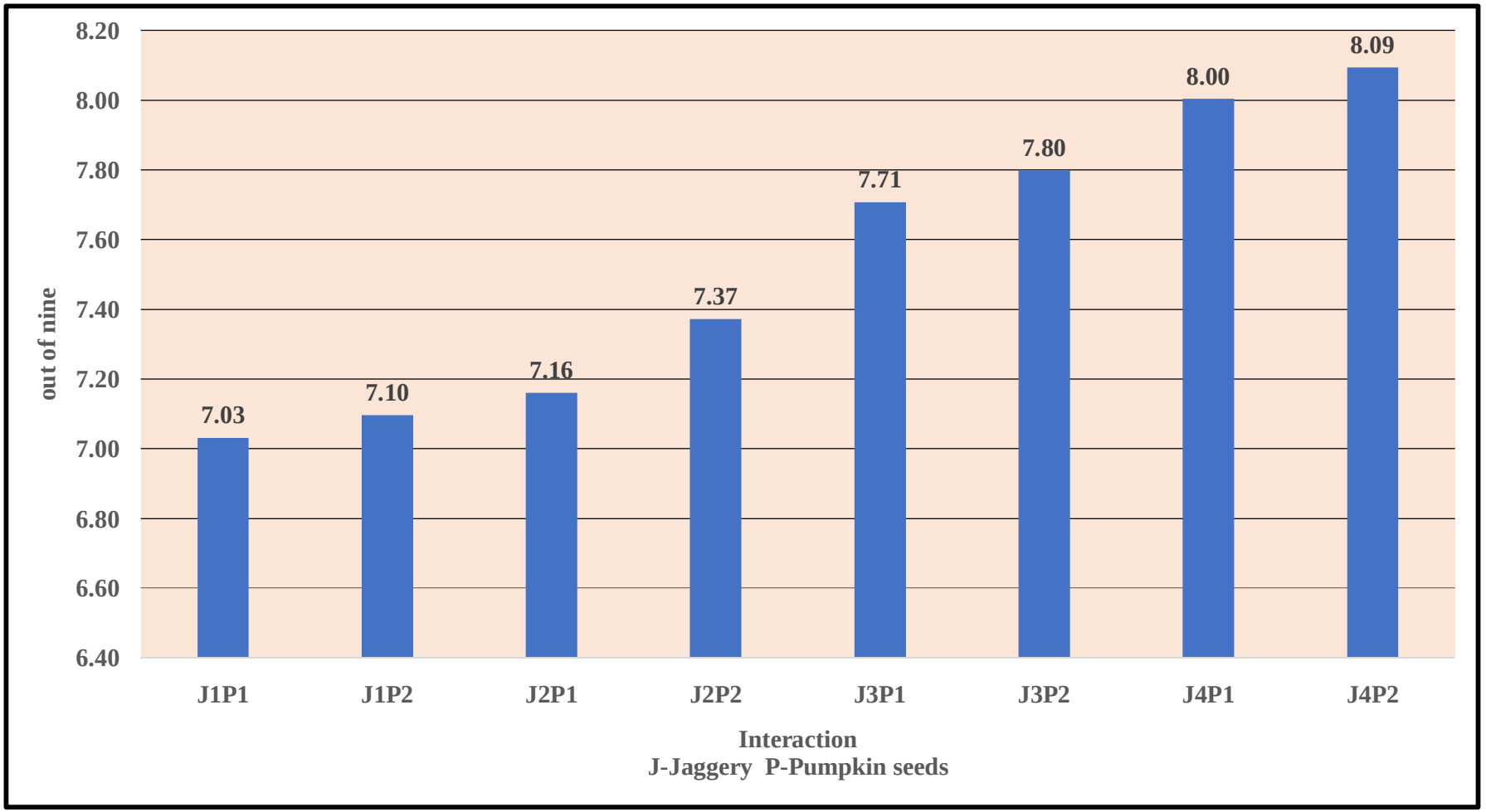


Fig 4 Effect of different levels of Jaggery and Pumpkin seeds on Body and texture of Khoa Modak (out of nine)

As regards to Pumpkin seeds it showed slight impact on body and texture of final product. However, there was slight increase in score for body and texture of Khoa Modak at higher level of addition of Pumpkin seeds i.e. 7.5 per cent.

Statistically interaction effect of both the factor i.e. Jaggery and Pumpkin seeds are found non-significant at ($p<0.01$)) level of significance.

It was concluded that both Jaggery has significant effect on body and texture of Khoa modak while Pumpkin seeds have non-significantly effect on final product Khoa Modak.

These finding are closely similar to Bhutkar et al. (2015) They studied the preparation of Peda blended with red pumpkin. They observed that increasing proportion of red pumpkin pulp in the blended in the khoa increased the score in respect of body and texture ranged between 8.0 to 9.0 for T_1 and T_3 treatment combinations.

Flavour

The score obtained for flavour at different treatments are determine in Table 8 and illustrated in Fig 5.

Table 8: Effect of different levels of Jaggery and Pumpkin seeds on Flavour of Khoa Modak (out of nine)

Levels of Pumpkin seeds (%)	Levels of Jaggery (%)				Mean
	J_1 (12)	J_2 (15)	J_3 (18)	J_4 (21)	
P_1 (5)	5.67	6.57	7.16	7.61	**6.75**
P_2 (7.5)	5.97	6.80	7.28	7.86	**6.98**
Mean	**5.82**	**6.68**	**7.22**	**7.73**	**6.87**

Table 9: Results of ANOVA (Flavour)

SV	DF	SS	MSS	Cal F	Tab F (5%)	Tab F (1%)	Sig
Treatment	8	20.52	2.56	9.88	2.24	3.13	**S**
Jaggery	3	19.96	6.65	25.64	2.90	4.46	**S**
Pumpkin seeds	1	0.51	0.51	1.98	4.15	7.50	**NS**
Interaction	3	0.04	0.01	0.06	2.90	4.46	**NS**
Error	**32**	8.30	**0.26**	--	--	--	--
Total	39	--	--	--	--	--	--

Table 10: Correlation Table (Flavour)

Particulars	S.E.(M)	C.D. 1%	C.D. 5%	5%	1%
Jaggery	0.16	0.23	0.46	**S**	**S**
Pumpkin seeds	0.11	0.16	0.33	**NS**	**NS**
Interaction	**0.2278**	**0.3221**	**0.66**	**NS**	**NS**

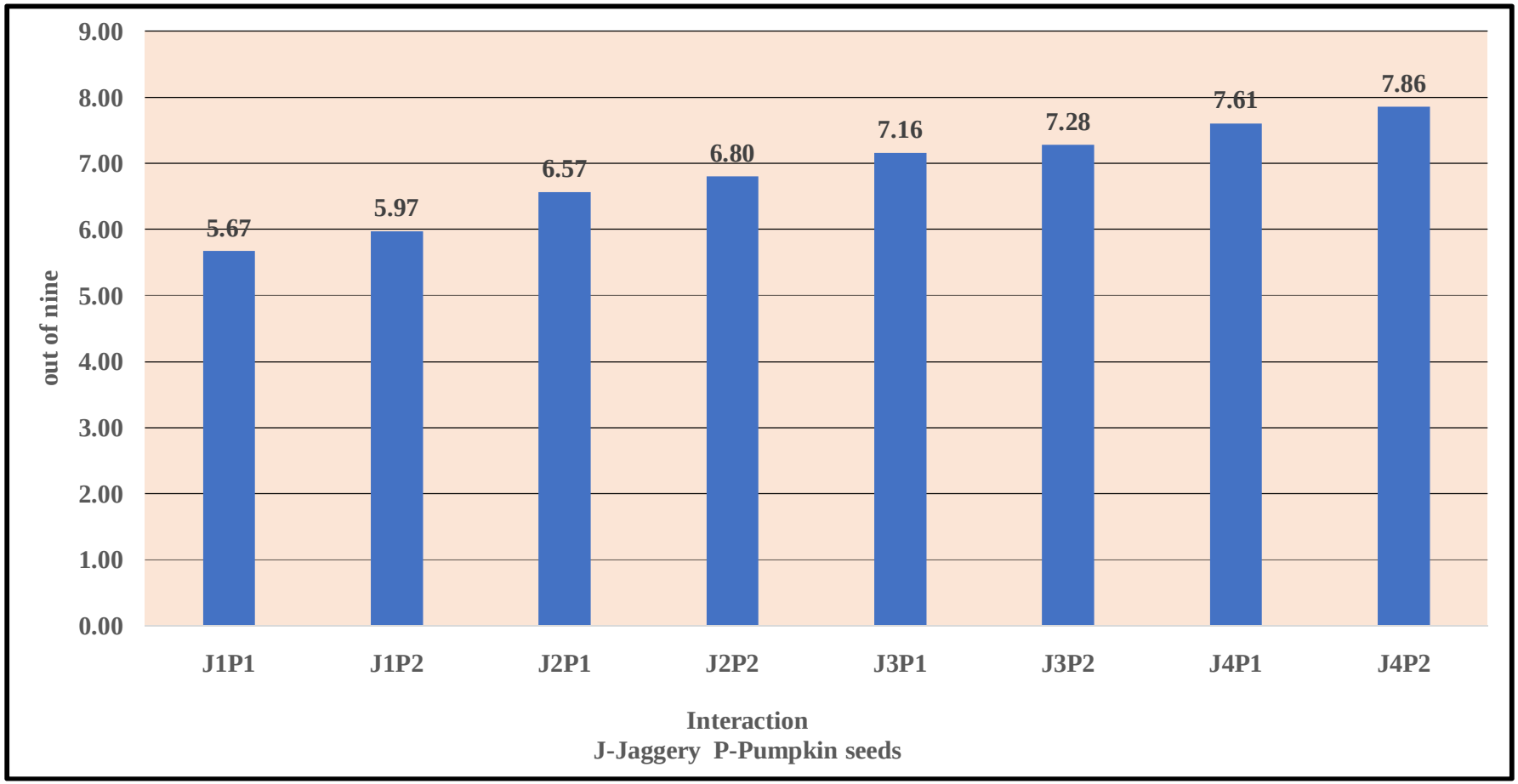


Fig 5. Effect of different levels of Jaggery and Pumpkin seeds on Flavour of Khoa Modak (out of nine)

Table 8 shows effect of different level of Jaggery and Pumpkin seeds on Flavour of Khoa Modak (out of nine). The variation in the taste score caused by different treatments was found to be considerable.

Jaggery is known for its typical burnt sweet, flavour so addition of Jaggery resulted in providing these typical taste and aroma to the product resulting in higher score for flavour parameter as level of Jaggery increases

The pumpkin seeds did not provide any pronounce effect on flavour attribute of the product because Pumpkin seed as such are flavour less.

Statistical data revealed that interaction effect of Jaggery and Pumpkin seeds was found non-significant at ($p<0.01$) levels of significance. Jaggery was found significant effect on final product while Pumpkin seeds was found non-significant effect on Khoa modak.

The present study was quite similar to findings of Bhutkar et al. (2015) They studied the preparation of Peda blended with red pumpkin. They observed that increasing proportion of red pumpkin pulp in the blended in the khoa increased the score in respect of flavour ranged between 8.0 to 9.0 for T_1 and T_3 treatment combinations.

Overall acceptability

The effect of Jaggery and Pumpkin seeds on overall acceptability of Khoa Modak is tabulated in Table 11 and illustrated in Fig 6..

Table 11: Effect of different levels of Jaggery and Pumpkin seeds on Overall acceptability of Khoa Modak (out of nine)

Levels of Pumpkin seeds (%)	Levels of Jaggery (%)				Mean
	J_1 (12)	J_2 (15)	J_3 (18)	J_4 (21)	
P_1 (5)	7.40	7.64	7.76	8.62	**7.85**
P_2 (7.5)	7.51	7.67	8.64	8.25	**8.02**
Mean	**7.46**	**7.65**	**8.20**	**8.44**	**7.94**

Table 12: Results of ANOVA (Overall Acceptability)

SV	DF	SS	MSS	Cal F	Tab F (5%)	Tab F (1%)	Sig
Treatment	8	8.62	1.08	37.45	2.24	3.13	**S**
Jaggery	3	6.31	2.10	73.05	2.90	4.46	**S**
Pumpkin seeds	1	0.27	0.27	9.29	4.15	7.50	**S**
Interaction	3	2.05	0.68	23.71	2.90	4.46	**S**
Error	**32**	0.92	**0.03**	--	--	--	--
Total	39	--	--	--	--	--	--

Table 13: Correlation Table (Overall Acceptability)

Particulars	S.E.(M)	C.D. 1%	C.D. 5%	5%	1%
Jaggery	0.05	0.08	0.15	**S**	**S**
Pumpkin seeds	0.04	0.05	0.11	**S**	**S**
Interaction	**0.075**	**0.11**	**0.22**	**S**	**S**

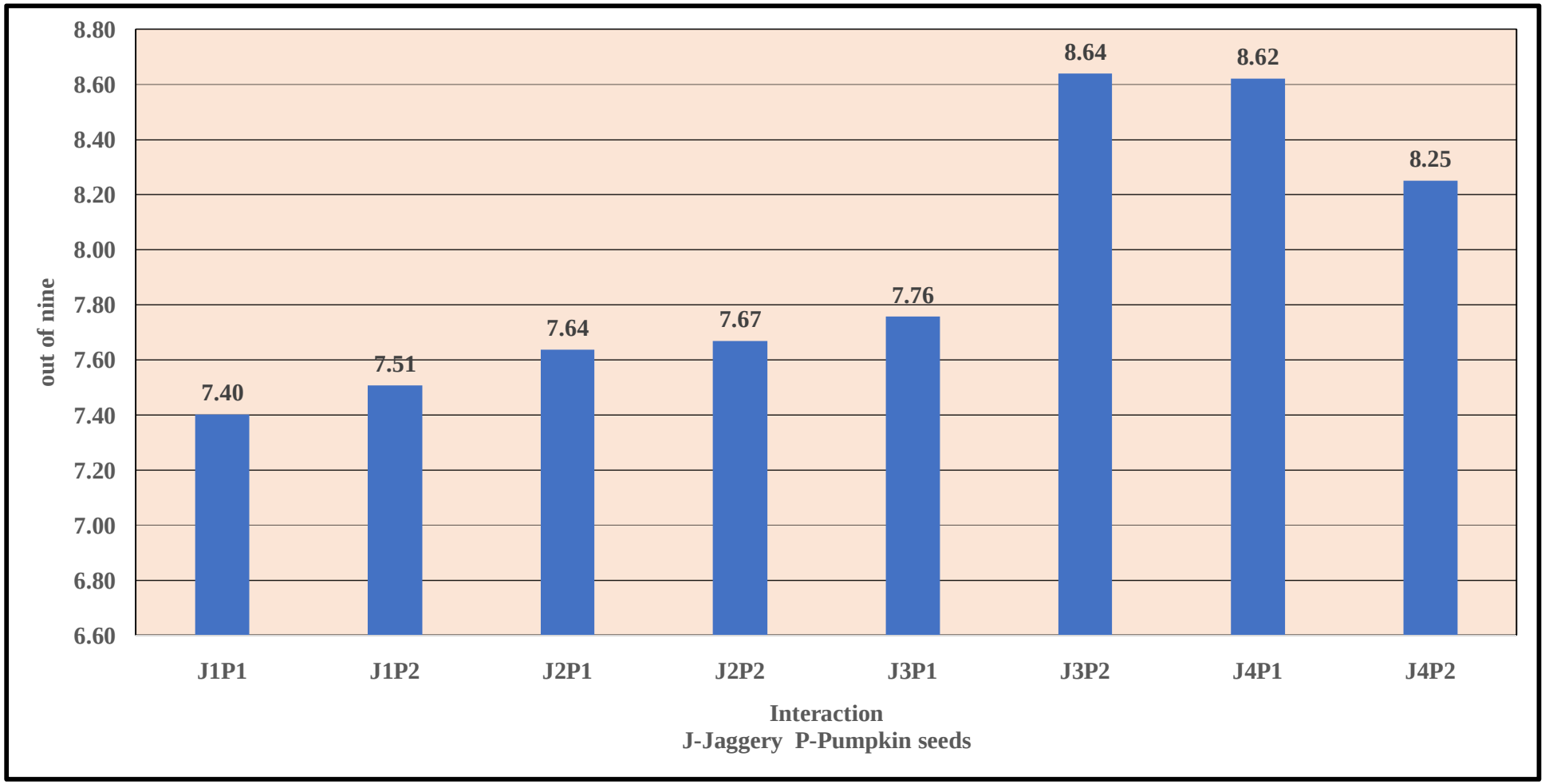


Fig 6. Effect of different levels of Jaggery and Pumpkin seeds on Overall acceptability of Khoa Modak (out of nine)

.

According to the overall acceptance scores shows in Table 11. It has been observed that treatment J_3P_2 (8.64) contain 18 (%) Jaggery and 7.5 (%) Pumpkin seeds provided most acceptable product it might be because of combine effect of typical aroma and flavour of Jaggery coupled with brightness of Pumpkin seeds.

The results indicated that both Jaggery and Pumpkin seeds are having significant impact on overall acceptability of product.

Statistical analysis of data indicated thar there is significant effect of Jaggery and Pumpkin seeds on overall acceptability of Khoa Modak at ($p<0.01$) level of significance. Interaction effect of both the factors found significant.

The present experimental study was similar to findings of Bhutkar et al. (2015) They studied the preparation of Peda blended with red pumpkin. They observed Peda samples in which 10 (%) red pumpkin pulp was blended with khoa scored the highest score (8.87) as compare to other treatments.

Cost of Production of Khoa Modak

The effect of different levels of Jaggery and Pumpkin seeds on cost of production of Khoa Modak is presented in Table 14 and Fig 7. The cost of producing 1 kg of Khoa Modak was found to be Rs. 328.28 in case of Khoa Modak prepared from 18 (%) Jaggery and 7.5 (%) Pumpkin seeds. The addition of Jaggery and Pumpkin seeds reduced the cost of producing Khoa Modak proportionally. The cost of Khoa Modak under treatments J_1P_1, J_1P_2, J_2P_1, J_2P_2, J_3P_1, J_3P_2, J_4P_1 and J_4P_2 was Rs. 331.62, Rs.337.23, Rs.327.08, Rs.332.65, Rs.322.76, Rs.328.28, Rs.318.65, Rs.324.12 per kg., respectively.

Cost of production of Khoa Modak was more comparable with Bhutkar et al. (2015) demonstrated the cost of final product was decreased from (T_1) Rs.260, (T_2) Rs.251, (T_3) Rs. 242 to (T_4) Rs. 234 per kg, respectively.

.

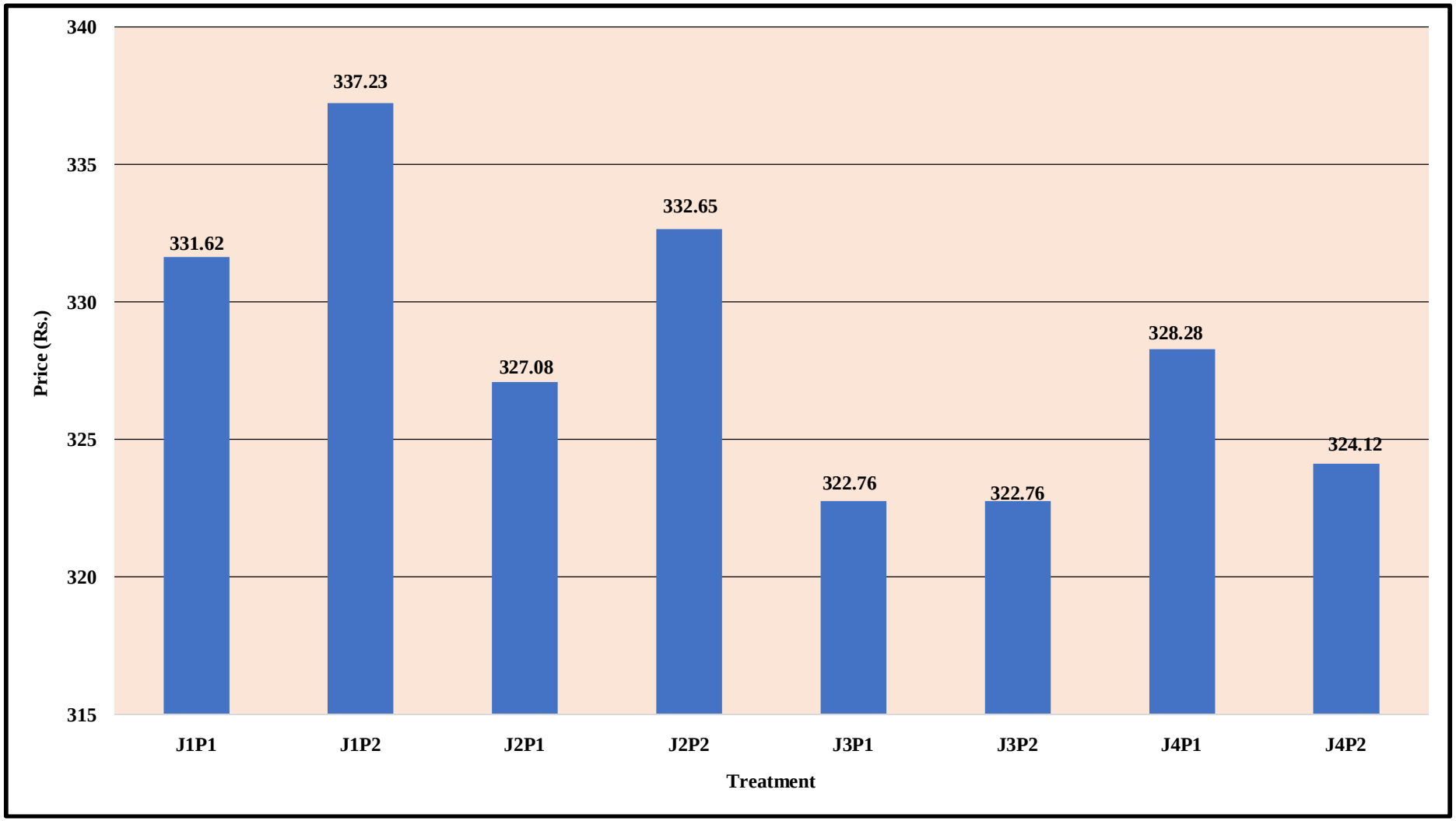


Fig 7. Cost of Production of Khoa Modak per kg in (Rs.) based on cost of ingredients only

.

Table 14 Cost of Production of Khoa Modak per kg in (Rs.) based on cost of Ingredients only

Ingredients	Price (Rs.)	Treatments															
		J_1P_1		J_1P_2		J_2P_1		J_2P_2		J_3P_1		J_3P_2		J_4P_1		J_4P_2	
		Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)	Qty (g)	Cost (Rs.)
Milk/ (lit)	56/-	600 (ml)	34	600 (ml)	34	600 (ml)	34	600 (ml)	34	600 (ml)	34	600 (ml)	34	600 (ml)	34	600 (ml)	34
Khoa/kg		100	34	100	34	100	34	100	34	100	34	100	34	100	34	100	34
Jaggery/ (kg)	150/-	12	1.8	12	1.8	15	2.25	15	2.25	18	2.70	18	2.70	21	3.15	21	3.15
Pumpkin seeds/(kg)	600/-	5	3.0	7.5	4.5	5	3.0	7.5	4.5	5	3.0	7.5	4.5	5	3.0	7.5	4.5
Total quantity of Khoa Modak Prepared (g)		117	38.80	119.5	40.30	120	39.25	122.5	40.75	123	39.70	125.50	41.20	126	40.15	128.50	41.65
Total cost (Rs.) of Khoa Modak/kg		331.62		337.23		327.08		332.65		322.76		328.28		318.65		324.12	

Cost of Ingredients: - Cow milk Rs.56/lit,

Khoa Rs.340/kg

Jaggery Rs.150/kg,

Pumpkin seeds Rs.600/kg

.

Summary

Sensory evaluation of Khoa Modak

Colour and appearance

From the above Table 2 it was observed that the highest score was attained with 18 (%) Jaggery and 7.5 (%) of Pumpkin seeds in treatment J_3P_2 (8.27) and the lowest score of treatment J_1P_1 (7.42) was obtained when 12 (%) Jaggery and 5 (%) of Pumpkin seeds was added, it could be attributed to the judges' dislike of Jaggery's light colour.

Body and texture

Table 5 showed Effect of different level of Jaggery and Pumpkin seeds on Body and Texture of Khoa Modak. Score of body and texture at 21 (%) of Khoa Modak has highest sensory score of treatment J_4P_2 is 8.09 and lowest in treatment J_1P_1 score 7.03. It had proper body texture and smoothness due to moisture of Jaggery.

Flavour

The flavour recorded at 21 (%) Jaggery which was greater than that at 12 (%) and 15 (%) and 18 (%) Jaggery, which was scaled up with scores of 5.67, 6.57 and 7.16 possibly due to the product's deep sweetness, which was liked by the judges. The judges preferred the product with the highest grade of treatment J_4P_2 (7.86) at 21 (%) Jaggery level for its mild sweetness and 7.5 (%) Pumpkin seeds level for its crispiness.

Overall acceptability

Khoa Modak with 18 (%) Jaggery and 7.5 (%) Pumpkin seeds had the highest overall acceptability score. The rigorous evaluation of the data indicates that of all the levels of Jaggery and Pumpkin seeds were significant ($p<0.01$) and had highest scored, the best product was obtained with 18 (%) Jaggery and 7.5 (%) Pumpkin seeds content. Hence, 18 (%) was chosen the most optimal level of Jaggery and 7.5 (%) of Pumpkin seeds for Khoa Modak preparation. At this quantity of Jaggery and Pumpkin seeds at 18 (%) and 7.5 (%) generated the highest quality product, with a score of treatment J_3P_2 (8.64). As a result, a reasonable level of Jaggery at 18 (%) and Pumpkin seeds at 7.5 (%) for producing the best quality Khoa Modak.

Cost of Production of Khoa Modak

The cost of producing one kg of Khoa Modak was found to be Rs. 328.28 in case of Khoa Modak prepared from 18 (%) Jaggery and 7.5 (%) Pumpkin seeds. The addition of Jaggery and Pumpkin seeds reduced the cost of producing Khoa Modak proportionally. The cost of Khoa Modak under treatments J_1P_1, J_1P_2, J_2P_1, J_2P_2, J_3P_1, J_3P_2, J_4P_1 and J_4P_2 was Rs. 331.62, Rs.337.23, Rs.327.08, Rs.332.65, Rs.322.76, Rs.328.28, Rs.318.65, Rs.324.12 per kg., respectively.

.

Conclusion

a) Jaggery and Pumpkin seeds could be successfully used for the preparation of Khoa Modak.
b) Used 18 (%) Jaggery and 7.5 (%) Pumpkin seeds to prepare most desirable and acceptable Khoa Modak.
c) Incorporation of Jaggery and Pumpkin seeds was suggested at pat formation stage.
d) Sensory score for all parameters of khoa modak increases as addition of Jaggery and Pumpkin seeds
e) Production cost of Khoa Modak decreases when addition of different levels of Jaggery and Pumpkin seeds
f) Significant difference was observed in organoleptic quality due to different levels of Jaggery and Pumpkin seeds in Khoa Modak.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc. have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

References:

A.O.A.C. 1995. Official methods of analysis, 12th Edition, Association of Official Analytical Chemists, Washington, D.C., U.S.A.

Bhutkar, S. S., Patil, D. L. and Rupanawar, D. A.2015. Studies on preparation of Peda blended with red pumpkin. IOSR J. Agri. Vet. Sci. 8(3):01-03.

Chaudhari. 2015. Studies on preparation of burfi blended with carrot pulp. M.Sc. thesis submitted to Dr. Punjabrao Deshmukh Krushi Vidyapeeth., Akola (M.S), India.

.

Food And Agriculture Organization of The United Nations – FAO. Statistics Division. 2022-23.

Fox P. F., Uniacke- Lowe T., McSweeney P. L. H., O'Mahony J. A. 2015. Dairy Chemistry and Biochemistry. 2nd Edn. Springer international publishing, Switzerland.

FSSAI Rules. 2011. Akalank's food safety and standards Act, rules and regulation. Akalank Publication, New Delhi.

FSSAI, The Food Safety and Standards Act, 2006 (Act No.34 of 2006, dt. 23-8-2006), Virag Gupta (Ed.), Commercial Law Publishers (India) pvt. Ltd., 10th Edn.2018. 375-378.

Gavhane, M. S., Kambale, N. S., Ghule, B. K. and More, K. D. 2015. To standardize the technology of ginger powder -based Peda, studies its chemical, sensory, bacteriological characteristics. Inter. J. Agri. Sci. and Res. 5(3):205-210.

Gavhane, M. S., Kamble, N. S., Desale, R. I., Ghule, B. K., and Mule, P. R. 2012. Studies on Preparation of Peda with Ginger Powder. Int. J. Food, Agri. and Veterinary Sci. 4(2):64-68.

Hoshing, S. P., Shegokar, S. R., Shelke, R. R., Kahandal, S. S., Chavan, S. D. and Kahate, P. A. 2023. Studies on sensory qualities of Burfi prepared from cow milk Khoa and beetroot (*Beta vulgaris*) pulp. The Pharma Innovation Journal. 12(1): 2040-2042.

I.S 2785 - 1964. Bureau of Indian Standards, New Delhi.

I.S.I Hand book of Food Analysis. Part II.1984.

IS 1166 - 1986 Specification for Condensed milk - Modified Lane and Eynon volumetric method. Bureau of Indian Standards, New Delhi.

IS 12333- 1997. Bureau of Indian Standards, New Delhi.

IS: 1224 Part-I (1977).Determination of fat by Gerber's method (Revised) Indian Standard Institution, Manak Bhavan, New Delhi, India.

IS: 1479 (Part-I) (1961) Methods for test for dairy industry. Rapid examination of milk. Indian Standard Institution, Manak Bhawan, New Delhi.

IS: 1479 (Part-II) (1961) Methods of test for dairy industry. Chemical analysis of milk. Indian Standards Institution, Manak Bhavan, New Delhi, India.

IS: 6287-1985 (Reaffirmed 2010) Methods of Sampling and Analysis for Sugar Confectionery.

.

IS:5550.2005.Bureau of Indian Standards, New Delhi.

IS:6273 part-I (1971) Guide for sensory evaluation of foods. Methods and evaluation cards, Indian standards Institution, Manak Bhavan, New Delhi, India.

I.S.I Hand book of Food Analysis.Part XI.1981.

Kaur, M. and Sharma, S. 2017a. Formulation and nutritional evaluation of cookies supplemented with pumpkin seed (*Cucurbita moschata*) flour. Chemical Science Review and Letters. 6 (24): 2236-2241.

Keerthi, S., Kartikeyan, S. and Adarsh, M. K. 2017.Storage studies of aloe vera juice incorporated Peda. International J. Food and Fermentation Tech.7(2):231-239.

Kumar, A., Upadhyay, N., Lal, D., Kumar, A., Gandhi, K., Sharma, V.2016. Effect of preparation and storage of khoa on physicochemical properties of milk fat. Int. J. Dairy Tech. 69:294–300.

Lambrini, K., Aikaterini, F., Konstantinos, K., Christos, I., Ioanna, P. V. and Areti, T.2020.Milk nutritional composition and its role in human health journal of pharmacy and pharmacology. 9: 10-15.

Maheshwari, P., Prasad, N., and Batra, E. 2014. Papitas-the underutilized byproduct and the future cash crop-A. Am. Int. J. Res. Formal, Appl. Natl. Sci.6 :31-33.

Patange, D.D., Kamble, D. K., Ranveer, R.C.2018. A text book on milk and milk products. Jaya publishing house. Delhi, India.

Pathak Vandana, Dwivedi, A. K.2019. Analytical study of different sample of guda (jaggery) Int. J. Inn. Sci. and Res. Tech.4(6).

Patil, R. V., Sawant, S. J., Sawant, D. N. and Todkar, S. R.2015. Physico-chemical analysis and sensory evaluation of burfi enriched with dried date. Journal of animal research. 5(1):131 – 134.

Ronald S., Kirk, Ronald, S., David.1991. Pearson's Composition and Analysis of Foods. 9th Edn. Longman Scientific and Technical Publisher. Harlow, UK.

Pravallika, B., Patel, S., Rao, P.V.K. Jagannadha and Sreedevi, P. 2018.Development and optimization of jaggery based cold extruded products Int. J. Curr. microbial. App. Sci. 7(9): 2950-2962.

Ranganna, S.1986. Handbook of analysis and quality control for fruits and vegetable products.

.

II[nd] Edition. Tata McGraw Hill Publishing Company, Ltd; New Delhi.

Saraswathi, D., Renu, R. and Maloo, S.2018. Development and quality evaluation of pumpkin seeds and flaxseeds powder incorporated biscuits. International Journal of Food Science and Nutrition. 3 (2): 78-83.

Srikanth, K., Kartikeyan, S. and M. Kalla, A. 2017. Storage Studies of Aloe vera Juice Incorporated Peda Intl. J. Food. Ferment. Tech. 7(2): 231-239.

Surve Shamika. 2017. Process standardization for preparation of milk shake by incorporation of date (*Phoenix dactylifera L.*) and jaggery. M.Sc. thesis submitted to Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli, Ratnagiri (M.S) India.

Thakare, N.S. 2019. Development of technology for manufacture of brown Peda containing jaggery. M.Sc. thesis submitted to department of dairy technology Sheth M.C. college of dairy science, Anand Agricultural University.(G.J) India.

Author details: -

1. Dhananjay Unde
   M.Sc. Student, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dr. B. S. K. K. V, Dapoli, Maharashtra, India. Email id- www.dhananjay8692@gmail.com.

2. Dr. Vijay kadav
   Assistant Professor, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dr. B. S. K. K. V, Dapoli, Maharashtra, India. Email id- vbkadav@gmail.com

3. Dr. Sandip Ramod
   Assistant Professor, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dr. B. S. K. K. V, Dapoli, Maharashtra, India. Email id- sandipramod28081981@gmail.com

Acknowledgement

// Shree Ganeshay Namaha //

First and above all, I praise God, the Almighty for providing me this opportunity and granting me the capability to proceed successfully. I bow my head in front of Lord who by his greatness has bestowed upon me the power of knowledge and a peaceful life without which I would have been nowhere.

Happiness lies in a pursuit as much as in reaching the goal and today I stand with the kernel of my endeavor. No words could adequately express my feelings; I shall ever remain gratefully indebted to them all. This note is just a reminder that they deserve more than just a "Thank You".

Everything in my life is nothing if I ignore the all-time encouragement, ever green affection, and latent love of my father ***Shri. Namdev Unde*** *and mother* ***Smt. Sunita Unde*** *which elevate my morals during the whole educational career. I extend my heartfelt gratitude to my sister* ***Mrs. Rutuja Unde.*** *Words are insufficient to take account of encouraging and evergreen love of my other family members whose silent presence has always guided my efforts.*

I express my reflective and enormous sense of thankfulness to an ever-inspiring personality, my Research Guide ***Dr. V. B. Kadav****, Chairman of my Advisory Committee and Assistant Professor, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli. I feel extremely blessed and fortunate to have such a positive thinking and serene professor as my guide. I hereby take this golden opportunity to express my gratefulness, indebtedness and sincere regards for his valuable and inspiring guidance, vital suggestions and his support and encouragement throughout the course of my study. I am now and will remain, extremely grateful for the invaluable guidance.*

I gratefully express my sincere thanks to the members of my Advisory Committee ***Dr. S. S. Ramod****, Assistant Professor, Department of Animal Husbandry and Dairy Science ,* ***Dr. N. N. Prasade*** *Associate Professor, Department of Animal Husbandry and Dairy Science,* ***Dr. M. M. Kulkarni,*** *Assistant Professor, Department of Horticulture, for their valuable suggestions and guidance throughout my research work.*

I express my pro- found thanks to ***Dr. A. J. Mayekar****, Head, Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli and special thanks to* ***Dr. V.S. Dandekar sir*** *Ex. Associate Professor Dept. of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli. for providing facilities, knowledge and experience during entire research work.*

I express my deep sense of honor to ***Dr. Sanjay Bhave****, Hon. Vice- Chancellor, Dr. B.S.K.K.V, Dapoli,* ***Dr. P. S. Bodake****, Dean, Faculty of Agriculture and* ***Dr. M.S. Joshi****, Associate Dean, College of Agriculture, Dapoli for providing necessary facilities and administrative help during the entire course of study. I also extend my sincere thanks to Shri. Rasal Sir, Agril. Assistant, Shri Dubale sir, Agril. Assistant, Shri. Agre sir, senior clerk, Dalwatkar sir, lab assistant, Sooraj, Dada peon and all the staff members of Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli for their kind co-operation throughout my studies.*

I am delighted to work with an enjoyable crew of friends every day. I express a great obligation of gratitude to my fellow batchmates Dwij, Shubham, Vinay, Akash, Nitish, Ryan and Vaishnavi.

Possibly words may limit my expression in whose company, I never felt the burden because I could see every helping hand in the dark of amalgam of tension and anxiety from my friends Yogiraj, Shrenik, Sanjay, Gopal, Ujwal, Tanmay, Ajit, Saurabh, Shubham Abhale, Shubham patil, Prajval, Sammed, Digambar, Gophane sir, Kiran, Swapnil, Sanjay, Amit, Rahul, Pawar Gopal, Bunty, Omkar, Enis, Yashwant, Viraj, Sarvesh, Vedant, Prathmesh, Rathod.

I cannot eschew to express my special thanks to my seniors, Vishal Sir, Amol Sir, Ashutosh Sir, Maleeha Madam, Sneha Madam, Divya Madam ,Mahima mam, Sumit sir, Dr. Shirsat sir and my beloved juniors Akash, Vidhi, Aishwarya, Neha ,Tejas, Vaibhav, Samantha and Shreyash for their necessary guidance and all help regarding this research work.

At the end I wish to thanks all those who directly or indirectly played pivotal role in successful completion of my post-graduation and this manuscript.

Place: Dapoli

Date: / /2024 ***(Unde Dhananjay Namdev)***

ABBREVIATIONS

%	: Per cent	et al.	: and others
/	: per	Viz.,	: Namely
i.e.	: id Est (that is)	ppm	: parts per millon
PFA	: Prevention of Food Adulteration Act	FCRD	: Factorial Completely Randomized Block Design
@	: At the rate of	TS	: Total Solid
^{0}c	: Degree Celsius	CV	: Coefficient of Variance
^{0}f	: Degree Fahrenheit	ANOVA	: Analysis of Variance
mg	: milli gram	CD	: Critical Difference
µ	: micron	MSS	: Mean Sum of Squares
Rs	: Rupees	SS	: Sum of Squares
Lit.	: Liter	S.E.	: Standard Error
Psi	: Per square inch	N.S.	: Non-significant
w/v	: Weight by volume	Sig	: Significance
w/w	: Weight by weight	S.V	: Source of variance
Cal	: Calories	D.F.	: Degree of Freedom

.

<	: Less than	Rep.	: Replication
>	: Greater than	SPC	: Standard Plate Count
Approx.	: Approximately	FSSAI	: Food safety and Standard Authority of India
E. coli	*: Escherichia coli*	BIS	: Bureau of Indian Standards
cfu	: Colony forming Unit	IS	: Indian Standards
MSNF	: Milk Solids Not Fat	ISI	: Indian StandardInstitute
Kcal	: Kilocalories	A.O.A.C.	: Association of official Analytical Chemist

.