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Preparation of value added healthy food product (*Thekua*) with incorporation of sorghum millet

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Abstract
Sorghum is one of the major cereal crop consumed in India after rice (*Oryza sativa*). It is of African origin. Sorghum is a gluten-free, high-protein, cholesterol-free source of a variety of essential nutrients, including dietary fiber, iron, phosphorus and thiamine
The present study was conducted to "Preparation of Value Added Nutritious Food Products with Incorporation of Sorghum Millet (*Thekua*)" with the objectives to determine the nutrient composition of jowar flour and acceptability of value added prepared products by the incorporation of jowar flour at different levels, to assess the organoleptic evaluation which were serve as treatment T_1 (refined flour + jowar flour 80:20), T_2 (refined flour + jowar flour 60:40) and T_3 (refined flour + jowar flour 40:60) respectively, and "*Thekua*" was served as treatment T_1 (refined flour + jowar flour 80:20), T_2 (refined flour + jowar flour 60:40) and T_3 (refined flour + jowar flour 40:60) without incorporation of "jowar flour" (T_0) served as control. They were replicated three times for all three products and orangoleptic evaluation was carried out using the nine point hedonic scale. Nutritional composition was calculated using the food composition table (Gopalan *et al.*, 2015), data obtained during investigation were statiscally analyzed by using analysis of variance (ANOVA) and critical difference (CD) techniques. On the basis of findings, was concluded that in case of "*Thekua*" 60 percent incorporation level of treatment T_3(40:60) scored the best with regard to colour and appearance, body and texture, taste and flavour, overall acceptability. The cost of products based on raw materials (Rs/ 100g). The cost of the *(Thekua*) ranged between Rs 9.25 to Rs 11.72.
Nutrient analysis of the products showed an increase in energy, fat, calcium, iron, fiber and protein content when compared with control. On the basis of findings we concluded that the products for prepared by incorporating jowar flour at different levels were at par with control/ conventional food products as well as improve the iron, fiber and calcium content.

Keywords: sorghum (Jowar), thekua, sensory evaluation

Introduction
Sorghum is an important crop worldwide, used for food (as grain and in sorghum syrup or "sorghum molasses"), animal fodder, the production of alcoholic beverages, and bio fuels. Sorghum is one of the staples for poor and rural people. Sorghum is a terrific substitute for traditional grains consumed in everyday diets. Sorghum is an excellent source of energy, it contains about 75 percent complex carbohydrate and it is also excellent source of iron and zinc and it is rich in B complex vitamins. Additionally, sorghum provides good to excellent sources of phytochemicals such as phenolic acids, anthocyanins, phytosterols and policosanols. Sorghum is also meeting gluten-free needs for those with celiac disease or a gluten-intolerance.
Sorghum is the fifth most important cereal grain crop in the world, largely because it grows well in many different environments. For thousands of years, sorghum has been a food staple around the world. Sorghum is naturally drought tolerant and its versatility as a food, feed and fuel. The sorghum species is Sorghum bicolour. The two sub-species of sorghum plant has two sub-species which are referred to as purple plant and tan plant. An easy way to identify which plant is purple or tan is by looking at the glume that surrounds the grain when it is ripe. The glume will be dark purple, if it is a purple plant and tan if it is a tan plant. Most often in the United States a white or crème coloured grain that is produced by tan plant sorghum is referred to as food-grade sorghum. This sorghum grain is very bland in flavour and may be milled into very nice white flour for gluten free food applications. The purple plant sorghums that produce white, red, bronze, or black colour grain may also be consumed as a food. The pigmented grains contain very unique phenolic compounds or antioxidants that are being researched for their possible health benefits and their use as natural food colorants.
Research shows that sorghum and pearl millet grains are nutritionally comparable or even superior to major cereals such as wheat and rice owing to higher levels of protein with more balanced amino acid profile, dietary energy, vitamins, several minerals (especially micronutrients such as iron and zinc), insoluble dietary fiber leading to lower glycemic index. In addition to their nutritive value, several potential health benefits such as preventing cancer and cardiovascular diseases, reducing tumour incidence, lowering blood pressure, risk of heart disease, cholesterol and rate of fat absorption, delaying gastric emptying, and supplying gastrointestinal bulk have been reported for millet (Gupta *et al.*, 2012) [5].

Jowar content very nutritional components, these are as follows:-Energy (kcal) 349, Protein (g) 10.4, Fat (g) 1.9, carbohydrate (g) 72.6, Calcium (mg) 25, Phosphorus (mg) 222, Crude fiber(g) 1.6, Moisture (g) 11.9 (Gopalan *et al.*, 2009) [4].

2. Materials and Methods

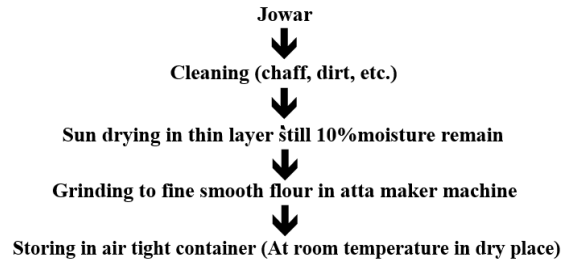
2.1 Procurement of raw materials

Organic de-husked sorghum was purchased from the market of Naini, Allahabad and other ingredients (refined wheat flour, sugar, oil, cheese, coconut, and vegetables etc.) were purchased from the local market of Allahabad.

2.2 Experimental Site

The present investigation was carried out in the Nutrition Research laboratory, Department of Food Nutrition and Public Health, Ethelind College of Home Science, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad.

2.3 Prepration of jowar flour



2.4 Treatments and replications of products

The basic recipes was serving as control (T_0)

Table 1: Detail of treatment of products (*Thekua)*

Food Products	Treatments				Replication
	T_0	T_1	T_2	T_3	
1. Thekua					
Refined wheat flour	100%	80%	60%	40%	3
Jowar flour	-	20%	40%	60%	

Details of treatments

Thekua was prepared using varying proportion of the main ingredients. Jowar flour and refined wheat flour.

Preparation of Thekua by incorporating jowar flour

- **T_0 (control):** the product was prepared using only 100g refined wheat flour without incorporating flours.
- **T_1:** the product was prepared using 80g, refined wheat flour, 20g jowar flour.
- **T_2:** the product was prepared using 60g, refined wheat flour, 40g jowar flour
- **T_3:** the product was prepared using 40g refined wheat flour, 60g jowar flour

2.5 Organoleptic evaluation of the products

Sensory evaluation of the food products for their acceptability was done by a panel of judges consisting of five faculty members from the Department of Food, Nutrition and Public Health, Ethelind College of Home Science. With the help of the Nine Point Hedonic Scale Score card (Appendix-A), judges were requested to score the products for different sensory attributes like colour and appearance, body and texture, taste and flavour and overall acceptability. (Srilakshmi, 2010).

2.6. Calculation of nutritive value of prepared products

The nutritive value obtained by the chemical analysis of the jowar flours was computed as well as food composition tables by Gopalan *et al*., (2015) was used to determine the nutritive value of the prepared products. Nutrients such as energy, protein, carbohydrate, fat, calcium, iron, fiber, thiamine and antioxidant were calculated.

Formula

$$\text{Nutrient/100g of product} = \frac{\text{Ingriedient used (g)} \times \text{Nutritive value of Ingriedient}}{100}$$

2.7. Determination of cost

Cost of the prepared products was calculated taking into account the cost of individual raw ingredients used in the preparation of food products as the prevailing market price.

2.8. Statistical Analysis

The data was statistically analyzed by using analysis of variance (two way classification) and critical difference technique. A significant difference between the treatments was determined by using CD (Critical difference) test. 't' test was performed for comparing the difference in the nutritional content between control and best treatment of the developed food products. **(Chandel, 2006).**

3. Results and Discussion

Finding of the present study entitled "Preparation of Value Added Nutritious Food Products with Incorporation of Sorghum Millet (*Thekua*)" on different aspects as per the methodology have been tabulated and analyzed statistically. The entire experiment was undertaken to jowar and then makes their flours for chemical analysis and prepares enriched products, i.e., healthy and nutritious product- *Thekua* using different flours combination. The results obtained from the analysis are presented and discussed in the following sequence.

- Chemical composition of jowar flours.
- Sensory characteristics of the developed food products.
- Nutritional composition of the products.
- Cost of the prepared food products.

Table 1: Chemical composition of the jowar flour (per 100 g)

Composition	Refined wheat flour	Jowar flour
Moisture (%)	13.3	11.9
Ash (g)	1.86	1.6
Protein (g)	11.0	10.4
Fat(g)	0.9	1.9
Crude Fiber (g)	0.3	1.6
Energy (kcal)	348	349
Carbohydrate (g)	73.9	72.6
Iron (mg)	2.7	4.1
Calcium(mg)	23	25
Thiamine (mg)	0.12	0.37

On comparing the chemical composition of refined wheat flour and jowar flour given by Gopalan *et al*., (2015) determined by self during research work in Nutrition Research Lab the observation made are as follows:

Nutrient content of jowar flour: The moisture content of jowar flour per 100g had obtained 11.9 decreased in comparison with refined wheat flour 13.3, the ash content of jowar flour had obtained 1.6 decreased in comparison refined wheat flour 1.86, the Protein content of jowar flour had obtained 10.4 g decreased in comparison in refined wheat flour 11g, the Fat content of jowar had obtained 1.9g increased in comparison with refined wheat flour 0.9g, the Crude fiber content of jowar flour had obtained 1.6g increased in comparison with refined wheat flour 0.3 g, the Energy content of jowar flour had obtained 349 kcal increased in comparison with refined wheat flour 348kcal, the Carbohydrate content of jowar flour had obtained 72.6g increased in comparison with refined wheat flour 73.9g, The iron content of jowar flour had obtained 2mg increased in comparison with 1.8mg, the Calcium content of jowar flour had obtained 25mg increase in comparison with refined wheat flour 23mg and the Thiamine content of jowar flour had obtained 0.37mg increased in comparison with refined wheat flour 0.12mg.

Organoleptic Evaluation

3.1 Thekua

Table 2: Average sensory scores of control and treated sample of *Thekua*.

Control and Treatments	Colour and Appearance	Body and Texture	Taste and Flavor	Overall Acceptability
T_0	7.4	7.4	7.8	7.6
T_1	7.9	7.9	8.33	7.93
T_2	7.86	8.06	8.16	8.13
T_3	8.3	8.4	8.7	8.76
F-test	S	NS	S	S
C.D	1.19	0.82	0.42	0.84

Colour and Appearance

F= 37.5(4.76), Significant, P≤0.05 CD=1.19

Body and Texture

F= 3.91(4.76), Non Significant, P≤0.05 CD=0.82

Taste and Flavour

F= 13.44(4.76), Significant, P≤0.05 CD=0.42

Overall acceptability

F= 6.025(4.76), Significant, P≤0.05 CD=0.84

The data illustrated in the above table (2) pertaining to the average sensory scores of different parameters in control and treated samples of *Thekua*, clearly indicates that in terms of colour and appearance T_3 (8.3) had the highest score followed by T_0, T_1 and T_2. T_2 had the highest score in other parameters i.e. overall acceptability making it quite obvious that the *Thekua* incorporated with 60 percent jowar flour, 40 percent refined wheat flour did have a golden and slight brown effect on the colour of *Thekua*. T_3 had the highest score in body and texture (8.4) and taste and flavour (8.7) making it obvious that the *Thekua* incorporated with 60 percent jowar flour, 40 percent refined wheat flour improved taste and flavour and body and texture of the *Thekua*..

Table 3: Analysis of Variance data for colour and appearance of *Thekua*

Sources of Variation	d.f.	S.S.	M.S.S.	F.cal.	F.tab. (5%)	Result
Due to treatment	3	2.70	0.9	37.5	4.76	S
Due to replication	2	0.055	0.027			
Due to error	6	0.3	0.024			
Total	11	3.05	0.95			

S = Significant (p≤0.05); NS = Non Significant

The ANOVA table 3 shows that calculated value of F (37.5) due to treatments is greater than the tabulated value of F (4.76) on 3, 6 degree of freedom at 5% probability level. It indicates that there was significant difference between the three treatments regarding the colour and appearance of *Thekua* and it can concluded that incorporation of jowar flour

with refined wheat flour improved colour and appearance of the prepared product, the colour and appearance is best till certain amount (T_3) after that is started decreasing.

Table 4: Comparison between the colour and appearance of the treatment of *Thekua* against C.D.

Treatment Mean value	T_0(7.4)	T_1(7.9)	T_2 (7.86)	T_3 (8.3)
T_0(7.4)		0.5	0.46	0.9
T_1 (7.9)			0.04	0.4
T_2 (7.86)				0.44
T_3 (8.3)				

CD= 1.19; *S = Significant (p≤0.05), NS = Non Significant

On comparing the average scores for colour and appearance of *Thekua* against critical difference in the table 4 the variation in scores for colour and appearance of *Thekua* can be seen as follows. The difference in the mean value of T_0, T_1 (0.5); T_0, T_2 (0.46); T_0, T_3 (0.9); T_1, T_2 (0.04); T_1, T_3 (0.4) and T_2, T_3 (0.44) were less than C.D. (1.19), therefore the difference was non-significant.

Table 5: Analysis of Variance data for body and texture of *Thekua*

Sources of Variation	d.f.	S.S.	M.S.S.	F.cal.	F.tab. (5%)	Result
Due to treatment	3	1.35	0.45	3.91	4.76	NS
Due to replication	2	0.01	0.005			
Due to error	6	0.69	0.115			
Total	11	2.05				

S = Significant (p≤0.05), NS = Non Significant

The ANOVA table 5 shows that calculated value of F (3.91) is greater than the tabulated value (4.76) on 3, 6 degree of freedom at 5% probability level. It indicates that there was significant difference between the three treatments regarding the body and texture of *Thekua* and it can concluded that incorporation of jowar flour with refined wheat flour improved of the prepared product, the body and texture is best till certain amount (T3) after that is started decreasing.

Table 6: Analysis of Variance data for taste and flavour of *Thekua*

Sources of Variation	d.f.	S.S.	M.S.S.	F.cal.	F.tab. (5%)	Result
Due to treatment	3	1.25	0.416	13.44	4.76	S
Due to replication	2	0.19	0.095			
Due to error	6	0.19	0.031			
Total	11	1.63	0.542			

S = Significant (p≤0.05), NS = Non Significant

The ANOVA table 6 shows that calculated value of F is greater than the tabulated value on 3, 6 degree of freedom at 5% probability level. It indicates that there was significant difference between the three treatments regarding the taste and flavour of *Thekua* and it can concluded that incorporation of jowar flour with refined wheat flour improved taste and flavour of the prepared product, the taste and flavour is become delicious till certain amount (T_3) decreased after that is started decreasing.

Table 7: Comparison between the taste and flavour of the treatment of *Thekua* against C.D.

Treatment Mean value	T_0(7.8)	T_1(8.33)	T_2 (8.16)	T_3 (8.7)
T_0(7.8)		0.53*	0.36	0.9*
T_1 (8.33)			0.17	0.37
T_2 (8.16)				0.54*
T_3 (8.7)				

CD= 0.42; S = Significant (p≤0.05), NS = Non Significant

On comparing the average scores for taste and flavour of *Thekua* against critical difference in the above table 7, the variation in scores for taste and flavour of *Thekua* can be seen as follows. The difference in the mean value of T_0, T_1 (0.53); T_0, T_3 (0.9) and T_2, T_3 (0.54) were greater than C.D, (0.42) therefore the difference is significant while the difference in the mean value of T_1, T_3 (0.37); T_0, T_2 (0.36) and T_1, T_2 (0.17) were less than C.D., therefore the difference is non-significant.

Table 8: Analysis of Variance data for overall acceptability of *Thekua*

Sources of Variation	d.f.	S.S.	M.S.S.	F.cal.	F.tab. (5%)	Result
Due to treatment	3	2.17	0.723	6.025	4.76	S
Due to replication	2	0.08	0.04			
Due to error	6	0.72	0.12			
Total	11	2.97	0.883			

S = Significant (p≤0.05), NS = Non Significant

The ANOVA table 8 shows that calculated value of F (6.025) due to treatments was greater than the tabulated value of F (4.76) on 3, 6 degree of freedom at 5% probability level. It indicates that there was significant difference between the three treatments regarding the overall acceptability of *Thekua* and it can concluded that incorporation of jowar flour with refined wheat flour improved overall acceptability of the prepared product, the overall acceptability is become accepted till certain amount (T3) after that is started decreasing.

Table 9: Comparison between the overall acceptability of the treatment of *Thekua* against C.D.

Treatment Mean value	T_0(7.6)	T_1(7.93)	T_2 (8.13)	T_3 (8.76)
T_0(7.6)		0.33	0.53	1.16*
T_1 (7.93)			0.2	0.83
T_2 (8.13)				0.63
T_3 (8.76)				

CD= 0.84; *S = Significant (p≤0.05), NS = Non Significant

On comparing the average scores for overall acceptability of *Thekua* against critical difference in the above table 9, the variation in scores for overall acceptability of *Thekua* can be seen as follows. The difference in the mean value of T_0, T_3 (1.16) was greater than C.D, (0.84) therefore the difference is significant while the difference in the mean value of T_0, T_1 (0.33); T_0, T_2 (0.53), T_1,T_2 (0.2); T_2, T_3 (0.63) and T_1, T_3 (0.83) was less than C.D., therefore the difference was non-significant.

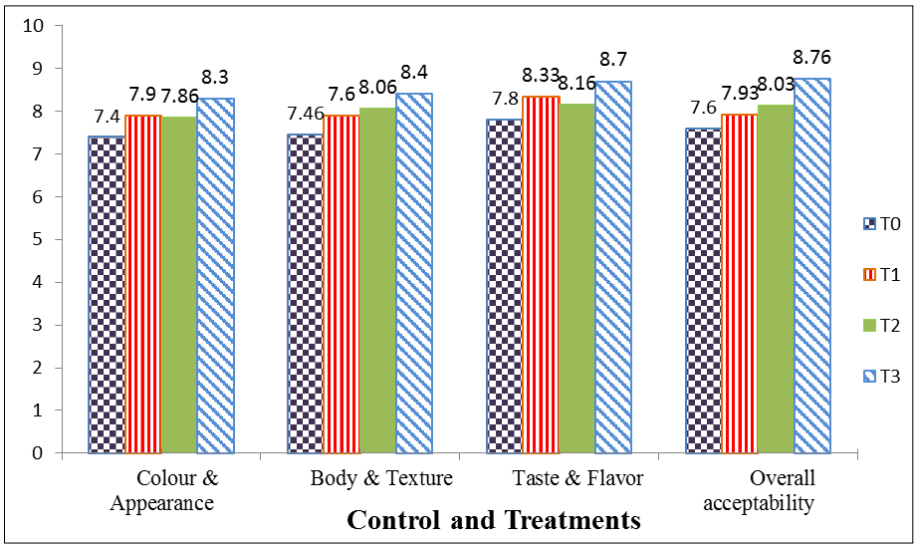


Fig 4.1: The effect of incorporation of jowar flour with refined wheat flour at different levels on the sensory attributes of *Thekua.*

Table 10: Comparison between nutrient content of control and best treatment of *Thekua* by using t-test

Nutrients	T_0	T_3	$T_3 - T_0$	t .cal.	t.tab. (5%)	Results
Energy	692	693	1	-2.42	2.9687	S
Protein	11	10.64	-0.36	3.244	2.9687	S
Fat	25.9	26.4	0.5	-4.90	2.9687	S
Carbohydrate	98.9	98	-0.90	-0.25	2.9687	NS
Calcium	27	28.2	1.2	-9.17	2.9687	S
Iron	2.78	3.55	0.77	-6.51	2.9687	S
Fiber	0.3	1.13	0.83	-19,02	2.9687	S

On comparing the nutrient content of control and best treatment of by using *Thekua* t-test in the table 10, the variation in nutrient content of *Thekua* can be seen as follows. The difference in the t- calculated value of energy, protein, fat, calcium, iron and fiber (T_3, T_0), was greater than t- tabulated (2.9687) at 5% probability level therefore the difference was significant. Indicating that the incorporation with jowar flour increased the energy, protein and fat content significantly more than control. The difference in the t- calculated value of carbohydrate (T_3, T_0), was less than t- tabulated (2.9687) at 5% probability level therefore the difference was non-significant.

Table 11: Cost of the prepared products namely *Thekua*

Ingredients	Actual rate/kg (Rs)	T_0		T_1		T_2		T_3	
		Amt. (g)	Cost (Rs)	Amt. (g)	Cost (Rs)	Amt. (g)	Cost (Rs)	Amt. (g)	Cost (Rs)
Jowar flour	80	-	-	20	1.6	40	3.2	60	4.8
Refined wheat flour	35	100	3.5	80	2.8	60	2.1	40	1.4
Sugar	40	35	1.4	35	1.4	35	1.4	35	1.4
Refined Oil	85	25	2.125	25	2.12	25	2.12	25	2.12
Coconut dry	200	10	0.4	20	0.4	20	0.4	20	0.4
Total amount (Rs.)			9.25		9.925		10.82		11.72

Table 11 shows that the total cost of *Thekua* per 100g of dry ingredients at the prevailing cost of the raw materials was T_0 is Rs. 9.25 for treatment, T_1 is Rs. 9.925, T_2 is Rs. 10.82 and T_3 is Rs. 11.72. It is therefore concluded that with the inclusion of jowar flour there was negligible difference found between the cost of the various treatments given i.e. T_1, T_2, T_3 and T_3 was found to be having the higher cost but the increase was negligible as compared to the market price and also possessing the potential nutritional benefits i.e. increase in micronutrient composition like calcium, fibre and iron. Hence, the slight increase in the cost of the treatments is well justified.

Summary and Conclusion

The present study entitled "Preparation of Value Added Nutritious Food Products with Incorporation of Sorghum Millet (Thekua)" was conducted in the Nutrition Research laboratory, Department of Food Nutrition and Public Health, Ethelind College of Home science, Sam Higginbottom University of Agriculture, Technology And Sciences, Allahabad U.P.

The study was undertaken with the following objectives:

1. To prepare jowar flour and analyze its nutritional composition.
2. To develop value added healthy food products (*Thekua)* with incorporation of jowar flour.
3. To assess the sensory evaluation of the prepared food products.
4. To determine the nutritive value and the cost of the prepared food products.

Frying cooking method was used to prepare the products namely, Thekua with three treatments and one control for each products *i.e.* T_1, T_2, T_3 and T_0 were jowar flour with refined

wheat flour and T_0 was prepared by 100 percent refined wheat flour. The experimental trail was replicated three times and in each replication of product (*Thekua*) was evaluated by a panel of five judges using 'Nine Point Hedonic Scales' for organoleptic properties and nutritive value was calculated using the food composition tables given by Gopalan *et al.*, (2015). The proximate chemical analysis of jowar flour was done with the use of AOAC (2005) [1]. The observations were recorded, tabulated and statistically analyzed by following analysis using variance and critical difference technique. Their costs of the products were calculated from the cost of raw materials used.

Sensory evaluation of Thekua with and without incorporation of Jowar flour with refined wheat flour showed that the overall acceptability was highest in T_3 (40 percent refined wheat flour+ 60 percent jowar flour) followed by T_2 (60 percent refined wheat flour+ 40 percent jowar flour) level of incorporation followed by and there was significant differences between the two. T_3 was found to be more acceptable than T_2 (60 percent refined wheat flour+ 40 percent jowar flour) and T_0 (100 percent refined wheat flour) control.

The Nutrients calculation of prepared products (*Thekua*, *Noodles and Pizza*) showed that the Energy, protein, calcium, Fiber and Iron content of the prepared products were increased by the incorporation of jowar flour with refined wheat flour. Energy, protein, fat, carbohydrate, fiber and iron were higher in T_3 in comparison with T_2 and T_1. But in Thekua carbohydrates and calcium contents were higher in T_1.

Comparison between nutrient content of control and best treatment of Thekua by using t- test the difference in the t-calculated value of energy, protein, fat, carbohydrate, calcium, iron and fiber was greater than t- tabulated (2.9687) at 5% probability level therefore the difference was significant

Average cost of *Thekua* per 100g on the basis of raw ingredients for T_0 is Rs. 9.25, T_1 is Rs. 9.925. It is therefore concluded that with the inclusion of jowar flour there was negligible difference found between the cost of the various treatments given i.e. T_1, T_2, T_3 and T_3 was found to be having the higher cost but the increase was negligible as compared to the market price and also possessing the potential nutritional benefits i.e. increase in macronutrient and micronutrient composition like energy, calcium, fibre and iron. Hence, the slight increase in the cost of the treatments is well justified. The control T_0 has the lowest cost and T_3 has the highest cost because the incorporation level of jowar flour did increase the cost of the prepared products marginally.

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