

Standardisation and Evaluation of Low Gluten Value Added Multi Grain Flour

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ABSTRACT

Most of the current existing multigrain atta(flour) contains maximum percentage (~90%) of wheat. This study has been undertaken to develop a multigrain flour with varying low proportions of wheat. An attempt was also made to develop a gluten free atta and evaluate its acceptability. The method of study is experimental. The product developed is a unique blend of Whole grains such as Whole wheat, Sorghum (Jowar), Pearl Millet (Bajra), Finger millet (Ragi), Foxtail millet, Defatted soy flour, Bengal gram dhal, Chia seeds, Psyllium husk and *Garcinia Cambogia* powder. In the experimental trials, Seven Variations of multigrain flour with varying proportions of grains such as Whole wheat, Sorghum (Jowar), Pearl Millet (Bajra), Finger millet (Ragi), Foxtail millet, Defatted soy flour, Bengal gram dhal, Chia seeds, Fenugreek seeds, Psyllium husk and *Garcinia Cambogia* powder were prepared. In each trial Chapathis were prepared with each multigrain flour variation and compared with the control (whole wheat-100%). A gluten free variation was also developed and Chapathis were made from each variation to study its acceptability. Sensory evaluation on organoleptic properties of Chapathis was done by 25 semi-trained panel members using 5-point Hedonic rating. Results revealed that multigrain flour with a proportion of Wheat: 60% Bengal gram+ Defatted soy flour: 20% Millets: 20% has significant higher mean scores, best rated, and was found to be not significantly different with the control ($P < 0.05$) and this proportion was standardized with appropriate packaging and nutritional labeling.

Keywords: Multigrain flour, low gluten, obesity, whole grains, millets, weight management.

INTRODUCTION

In India for the majority of the population staple food in their diet is wheat, rice and maize. It has been proved that regular consumption of only single food items affects health. Diet should be balanced besides being it should be wholesome, appetizing, palatable and satisfying. It has been proved that right food can cure several diet related disorders^[1].

A study in 2004 showed that whole-grain intake is protective against cancer, CVD, diabetes, and obesity^[7]. A systemic review of case-control studies conducted using a common protocol indicates that a higher frequency of whole-grain consumption is associated with a reduced risk for cancer^[1]. Whole grains are rich in compounds that help in the prevention of several chronic diseases like ischemic strokes, cardiovascular diseases, cancers, obesity and type II diabetes^[8].

It has been hypothesized that dietary cereal grain protein, could cause leptin resistance by preventing leptin from binding to the leptin receptor^[9]. Leptin resistance is considered a primary risk factor for the pathogenesis of overweight and obesity, which in turn is closely associated with various metabolic disorders including dyslipidemia, stroke, insulin resistance and Type II diabetes^[12].

Value-Addition is the process of taking a raw commodity and changing its form to produce a high quality end product in order to meet the tastes of consumers. In the development of low gluten value added multigrain flour, value addition refers to nutrient rich flour with soluble fibre, iron, calcium, low gluten, high protein flour, providing health benefits.

Dietary research is directed towards correcting the obesity and its associated diseases by combination of cereals, legumes and oil seed, which has proved beneficial in the weight management ^[10]. Due to the increased risk of morbidity and mortality, obesity is now being recognized as a disease in its own right. Additionally, obesity is strongly associated with other metabolic disorders including diabetes, hypertension, dyslipidaemia, cardiovascular disease and even some cancers. According to the WHO World Health Statistics Report 2012, globally one in six adults is obese and nearly 2.8 million individuals die each year due to overweight or obesity World Health Organization (WHO) ^[15]. The prevalence of obesity among Indian women has increased from 10.6 per cent (NFHS-2 in 1998-1999) to 12.6 per cent (NFHS-3 in 2005-2006), i.e. an increase by 24.52 per cent in a seven year period^[5]. Obesity, particularly in young women, can have important consequences like infertility and development of polycystic ovary syndrome (PCOS) ^[13].

The purpose of the study is to develop and standardise a healthy low gluten value added multi grain flour that can increase the intake of millets in the daily diet. Low gluten value added multigrain flour is a unique blend of Whole grains such as Whole wheat, Sorghum (Jowar), Pearl Millet (Bajra), Finger millet (Ragi), Foxtail millet, Defatted soy flour, Bengal gram dhal, Chia seeds, Fenugreek seeds, Psyllium husk and extract of *Garcinia Cambogia*.

MATERIALS AND METHODS

The study was carried out at Department of Food and Nutrition, Smt. V.H.D Central Institute of Home Science and Research Centre, Bangalore. The method used for the study is Experimental.

Procurement of raw materials

The raw grains were procured from a wholesale shop, ChennuPapaiah whole grain store in Begum Bazar, Hyderabad. The grains purchased were Finger millet, Sorghum, Pearl Millet, Whole wheat, Whole Bengal Gram, Foxtail millet, Fenugreek. The grains were stored in gunny bags. Defatted soy flour of brand “Bhagirathi” was purchased from Ekta Enterprises, Banjara Hills. *Garcinia Cambogia* powder and Psyllium husk powder was purchased from organic store Nature’s basket.

Processing of raw materials:

All the grains were cleaned separately to remove any stones, dust, other grains, sticks etc. All the grains were washed and sundried for 48 hours to reduce the moisture content. The grains were given for milling separately in a local flour mill and stored in double layered cloth bags.

Development of the product:

Development of seven variations of low gluten value added Multigrain Flour and a gluten free variation was undertaken in this study (Figure .1). Various experimental trials of chapathis from different flour mixes were carried out with varying proportions of different ingredients and compared with the control (whole wheat-100%). Evaluation of each trial was done and adjustments were made in the proportions of the ingredients depending on the dough pliability, time of kneading, desired organoleptic properties of the chapathi and amount of time required to prepare a chapathi.

Sensory Evaluation

Sensory evaluation was carried out to find the acceptability of the low gluten value added multigrain flour using 5 point hedonic scale. Sensory evaluation was done by 25 panel members and results were tabulated. Various characteristics like appearance, color, flavor, texture, overall acceptability were scored from a rating 5 to 1. The ranks were categorized as 1 – poor, 2 – fair, 3 – good, 4 – very good and 5 – excellent.

Statistical analysis

Statistical Analysis was done using the software SigmaPlot version 12.5. The data includes mean scores for each sample as tested by the panel members. The results of sensory evaluation were individually subjected to one way analysis of variance (ANOVA) test to determine the differences of the mean scores for appearance, colour, flavour, texture, and overall acceptability at $P < 0.05$

Standardization of low gluten value added multigrain flour

Based on the results a low gluten value added multigrain flour was standardized with respect to its acceptable organoleptic properties that were close to the control.

Shelf life study (physical examination) of standardized product

The shelf life of a product can be defined as the time phase in which the product is safe and has acceptable qualities to be purchased and consumed. Shelf life studies were carried out at room temperature (36°C) and at refrigeration (0-5°C) to check the keeping quality of flour.

Nutritional composition study of standardized product

Nutritional composition of the standardized low gluten value added multigrain flour was calculated referring the nutrient composition tables given in Nutritive Value of Indian foods (NIN, Hyderabad)^[2].

Packaging

Double layered Polypropylene food grade zip lock covers are used as packaging material. It is an acceptable food grade packaging material. It is resistant to sunlight, air, humidity therefore prevents degradation of the product that is used to preserve.

Nutritional labeling: Nutritional labeling was made on the packages with all the necessary details. Nutritional labeling and packaging is a vital process in the food processing chain and the label bridges the gap between a consumer and the producer. Apart from being informative packaging and labelling makes a finished product attractive so that it also acts as a tool for marketing.

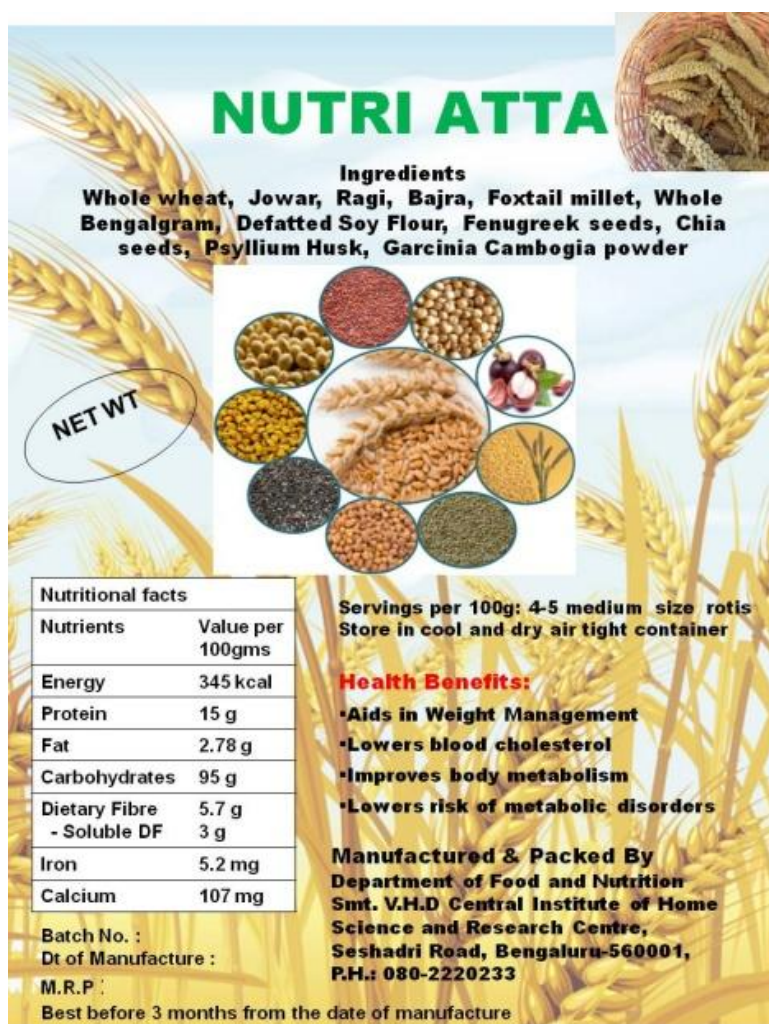


Figure No.1 shows Nutritional Labelling developed for standardized low gluten value added multigrain atta (flour)

Costing

Costing is a critical factor for economic success of the developed end product . It makes it easier for people from all economic backgrounds in making a conscious decision regarding the purchase of the finished product. For the Bulk Production, food ingredients and packaging material were bought from the wholesale markets to reduce the expenses and increase the profit

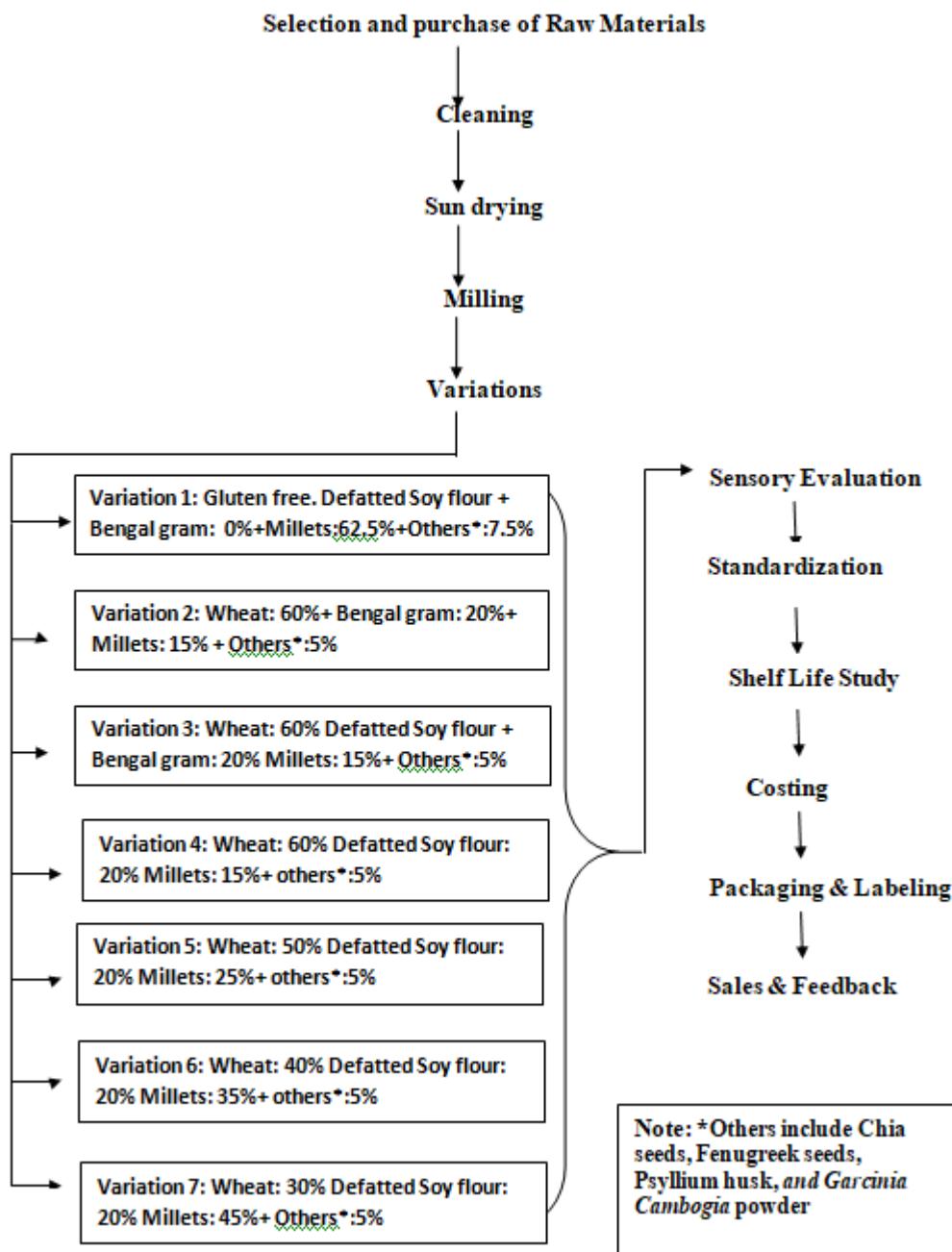


Figure No.2 Plan of work for Development of low gluten value added multigrain flour

RESULTS AND DISCUSSION

Different preliminary trials were carried out to make chapathis and to observe the sensory attributes of chapathis such as appearance, colour, flavor and texture. The following table shows the composition of different multigrain composite flour mixes. The chapathis from the trials that were acceptable in its organoleptic properties were accepted as a variation for sensory evaluation.

Table 1 : Preliminary Trials-Composition of Different multigrain composite flour mix.

	Gluten Free				With decreasing proportions of wheat (gluten)					
TRIALS	1	2	3	4	5	6	7	8	9	10
INGREDIENTS	Not accepted			Accepted	Accepted					
Whole Wheat	0%	0 %	0 %	0%	60%	60%	60%	50%	40%	30%

Jowar	15%	10%	10%	10%	3%	3 %	3%	4 %	7%	10%
Bajra	20%	22.5%	22.5%	22.5%	3%	3 %	3%	8 %	11%	14%
Ragi	20%	22.5%	22.5%	22.5%	3%	3 %	3%	8 %	12%	15 %
Foxtail millet	10%	10%	10%	7.5%	5%	5 %	5%	5 %	5%	5 %
Deffatted soy flour	10%	30%	0 %	15%	-	10%	20%	20%	20%	20%
Whole bengal gram	10%	-	30%	15%	20%	10 %	-	-	-	10%
Fenugreek seeds	5%	0.5%	0.5%	2.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Chia Seeds	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Psyllium Husk	1.5%	1.5%	1.5%	1.5%	1%	1%	1%	1%	1%	1%
<i>Garcinia Canbogia</i> powder	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%

OBSERVATIONS

Table 2: Preliminary trials of different accepted multigrain composite flour mix based chap a this with observation.

TRIAL No.	Appearance	Colour	Flavour	Texture	Comments
1	Cracks on the surface	Brown	Bitter	Hard	Difficulty to knead and roll a sheet. Chapathi with breakages and bitter
2	Cracks on the surface	Brown	Bitter	Little hard	Decrease the percentage of Fenugreek seeds and millets and increase the percentage of pulses
3	Cracks on the surface	Brown	Bland	Crisp hard	Trail made out of defatted soy flour and can be observed with Bengal gram flour
4	Cracks at the edges	Brown	Bland	Little soft	Difficulty to knead and roll a sheet. Cracks at the edges. Chapathi with breakages.
5	Appealing	Brown	Bland	Soft	Good in overall acceptability
6	Appealing	Brown	Bland	Soft	Good in overall acceptability
7	Appealing	Brown	Bland	Soft	Good in overall acceptability
8	Appealing	Brown	Bland	Soft	Good in overall acceptability
9	Appealing	Brown	Bland	Crisp	Difficulty to roll a sheet. Chapathi is little hard
10	Appealing	Brown	Bland	Hard	Little hard.

Table 3: Sensory Evaluation - Mean scores of the accepted variations of different multigrain composite flour mix.

*

Variation (V)	Appearance	Colour	Flavour	Texture	Overall Acceptability
	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD	Mean \pm SD
V 1	4.040 \pm 0.841 ^a	3.88 \pm 0.881 ^a	3.92 \pm 1.115 ^a	3.92 \pm 0.954 ^a	3.960 \pm 1.020 ^a
V 2	4.360 \pm 0.700	4.080 \pm 0.909	4.08 \pm 0.909 ^a	4.20 \pm 0.913 ^a	4.200 \pm 0.764 ^a
V 3	4.360 \pm 0.757	4.280 \pm 0.737	4.28 \pm 0.737^a	4.28 \pm 0.843^a	4.400 \pm 0.707
V 4	4.240 \pm 0.831	4.280 \pm 0.843	4.28 \pm 0.792^a	3.96 \pm 0.935 ^a	4.200 \pm 0.764 ^a
V 5	4.040 \pm 0.790 ^a	4.04 \pm 1.060 ^a	3.96 \pm 0.935 ^a	3.76 \pm 0.879 ^a	3.960 \pm 0.735 ^a

V 6	4.000 ± 0.816^a	3.92 ± 0.954^a	4.16 ± 0.987^a	3.92 ± 0.954^a	4.240 ± 0.831^a
V 7	3.960 ± 0.889^a	3.96 ± 1.06^a	3.96 ± 1.098^a	4.00 ± 0.957^a	4.120 ± 0.927^a
Control	4.76 ± 0.436	4.68 ± 0.476	4.88 ± 332	4.84 ± 0.374	4.8 ± 0.408

*Mean Scores of 25 panel members.

Values for Mean \pm SD with same superscript (a) within the same column differ significantly with control ($p < 0.05$)

Table 4 : Accepted Multigrain Flour- One Way Anova (Anlaysis Of Variance): Multiple Comparision Test With The Control: Holm Sidak Method

Calculated P Value of Variations with overall Significance level $P < 0.05$							
Variations	I	II	III	IV	V	VI	VII
Appearance	0.004 ^{SD}	0.067	0.13	0.052	0.006 ^{SD}	0.004 ^{SD}	0.002 ^{SD}
Colour	0.011 ^{SD}	0.051	0.111 ^{SD}	0.21	0.044 ^{SD}	0.016 ^{SD}	0.022 ^{SD}
Flavor	0.001 ^{SD}	0.007 ^{SD}	0.019 ^{SD}	0.037 ^{SD}	0.002 ^{SD}	0.015 ^{SD}	0.002 ^{SD}
Texture	0.001 ^{SD}	0.02 ^{SD}	0.024 ^{SD}	0.002 ^{SD}	0.001 ^{SD}	0.001 ^{SD}	0.002 ^{SD}
Overall Acceptability	0.001 ^{SD}	0.023 ^{SD}	0.074	0.03 ^{SD}	0.002 ^{SD}	0.025 ^{SD}	0.013 ^{SD}

*P values with superscript (SD) within the same row shows that they are significantly different with the control

Purchase of grains, Psyllium Husk Powder, *Garcinia Cambogia* Powder

(Grains: Whole wheat, Sorghum (Jowar), Pearl Millet (Bajra), Finger millet (Ragi), Foxtail millet, Bengal gram dhal, Chia seeds, Fenugreek seeds)

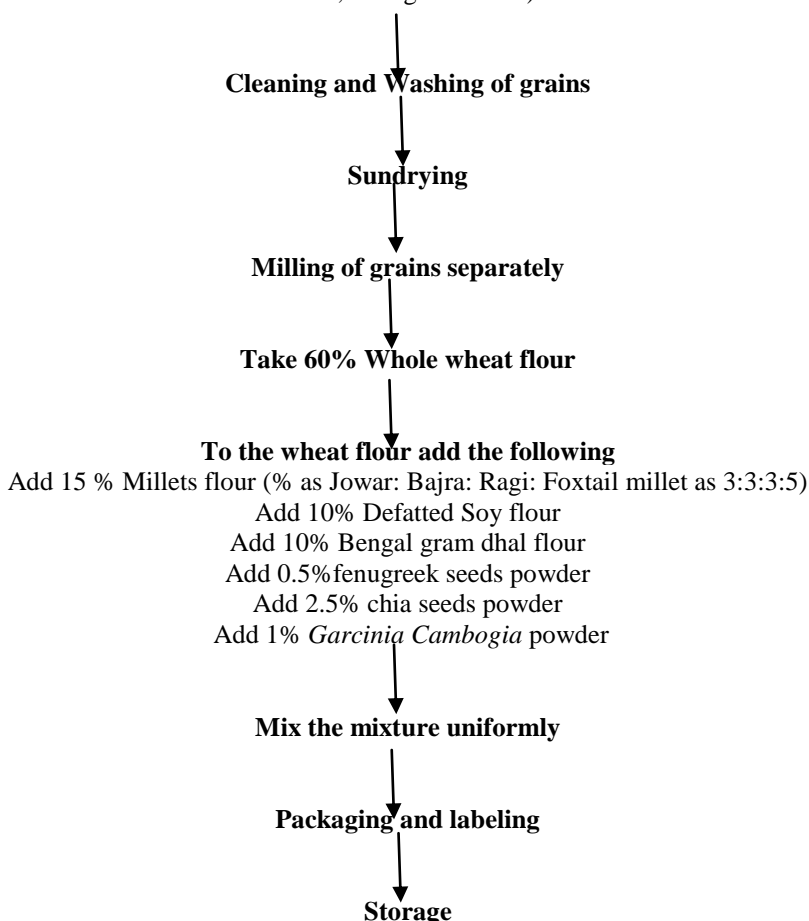


Figure 3 : Standardized Low Gluten Value Added Multigrain Flour (Final Product)

Table 5: Ingredients Composition of Standardized low gluten value added multigrain flour

Ingredients	Quantity per 100gms
Whole Wheat	60 g
Jowar	3 g
Bajra	3 g
Ragi	3 g
Foxtail millet	5 g
Deffatted soy flour	10 g
Whole bengal gram	10 g
Fenugreek	0.5 g
Chia Seeds	2.5 g
Psyllium Husk	1 g
<i>Garcinia Cambogia powder</i>	1 g

Table 6: Nutritional Composition of Standardized low gluten value added multigrain flour

Nutritional Value	
Nutrients	Value per 100gms
Energy	345 kcal
Protein	15 g
Fat	2.78 g
Carbohydrates	95 g
Dietary Fibre - Soluble DF	5.7 g 3 g
Iron	5.2 mg
Calcium	107 mg

SHELF LIFE STUDY OF STANDARDIZED BEST RATED LOW GLUTEN VALUE ADDED MULTIGRAIN FLOUR (Physical examination)

The shelf life of a product can be defined as the time phase in which the product is safe and has acceptable qualities to be purchased and consumed. The standardized low gluten value added multigrain flour packed in double layered zip lock cover was observed kept at room temperature (36°C) and at refrigeration (0-5°C). Shelf Life of the standardized product was observed at room temperature (36°C) and at refrigeration (0-5°C). It was seen that at room temperature, the quality of the standardized low gluten value added multigrain flour was good till three months without any infestation or undesirable changes; the texture was same as day one and there was no off odour from the flour. At refrigeration temperature (0-5°C), there was absence of infestation, no off odour from the flour, but there was increase in moisture of the flour as perceived through hand feel.

Table 7: Shelf life study of standardized, best rated, low gluten value added multigrain flour (physical examination)

(Physical examination)	At Room Temperature (36°C)			At Refrigeration temperature (0-5°C).		
Days	30days	60days	90days	30days	60days	90days
Appearance	Creamy White	Creamy White	Creamy White	Creamy White	Creamy White	Creamy White

Texture	Fine flour without any lumps	Fine flour without any lumps	Fine flour without any lumps	Fine flour without any lumps. Presence of Moisture	Fine flour without any lumps Presence of moisture	Fine flour without any lumps Presence of moisture
Odour	No off odour	No off odour	No off odour	No off odour	No off odour	No off odour
Presence of Infestation	Absent	Absent	Absent	Absent	Absent	Absent

Table 8: Cost of standardized low gluten, best rated value added multigrain flour

	Quantity per 100gms	INR (Rupees)	Rupees per kg
Whole wheat	60 g	1.8	30
Jowar	3 g	0.135	45
Bajra	3 g	0.084	28
Ragi	3 g	0.084	28
Foxtail millet	5 g	0.4	80
Deffatted soy flour	10 g	0.85	85
Whole bengal gram	10 g	0.85	85
Fenugreek seeds	0.5 g	0.12	240
Chia seeds	2.5 g	2.5	1000
Psyllium husk	1 g	1.95	1950
<i>Garcinia Cambogia</i> powder	1g	0.5	500
Total Ingredients cost per 100gms of product		9/-	
Overhead charges* @30%		3/-	
Total per 100gms of product		12/-	
Total per 150gms of product		15/-	

*Overhead charges includes electricity, equipment costs, packaging and labeling costs



Figure 3, showing Nutri Atta (flour) was sold in the college exhibition with good sales and very good feedback.

DISCUSSION

Seven variations of multi grain flour have been developed with different proportions of wheat and one without wheat. Various trials of chapathi using different combination of flours were carried out. Sensory evaluation was done by a group of 25 panel members and response was recorded and tabulated.

The mean sensory scores (Table No.3) for appearance ranged from 3.96 to 4.36, lowest being for the Variation VII and the maximum being for Variation III. The mean scores for flavor ranged from 3.92 to 4.28, where Variation III and Variation IV showed the maximum mean score of 4.28. The mean scores for texture and overall acceptability was higher for Variation III i.e 4.2 and 4.4 respectively. The mean scores for overall acceptability was highest for Variation III and fell under the category of "Excellent". It can be concluded that among all the variations, Variation III (Wheat: 60% Defatted Soy flour + Bengal gram: 20% Millets: 20%) was found to be more acceptable than others and selected by the panel members and has significant higher mean scores for appearance (4.36), color (4.28), flavor(4.28), texture(4.28), overall acceptability (4.4).

The results of sensory evaluation were individually subjected to one way analysis of variance (ANOVA) test. Table No.4 shows multiple comparison test significance with the control and the overall significance level is $P < 0.05$. It shows that the chapathis made from Variation III is similar to the control in appearance and overall acceptability of the product. All the other variations have a significant difference with the control in all the attributes such as appearance, color, flavor, texture and overall acceptability. However flavor is significantly different from the control because of the different grains present in it.

Hence Variation III with a proportion of Wheat: 60% Bengal gram+ Deffatted soy flour: 20% Millets: 20% was standardized. Table 5, gives Ingredient composition of standardized product. The nutritional composition of the standardized product is given in Table 6.

Shelf Life of the standardized , best rated product (Table 7) was observed (physical examination) at room temperature (36°C) and at refrigeration ($0-5^{\circ}\text{C}$). It was seen that the quality of the standardized low gluten value added multigrain flour was good till three months without any infestation; the texture was same as day one and there was no off odour from the flour.

A similar study was done to study the acceptability of developed nutrient rich multigrain based flour for weight reduction , a combination of multigrain flour prepared using oat, barley, soybean, wheat and flaxseed combination in the ratio of 35:25:20:15:5 respectively was found to be more organoleptic acceptable^[10]. In the same way study undertaken in (2006) to develop composite flour, was prepared by incorporating flaxseed flour with wheat flour at 5, 10, 15, 20, 25 and 30 percent level and results revealed that mean quality score of flour decreased with the increase in the level of the flaxseed flour supplementation^[4]. However a study in 2010 showed the effect of replacement of wheat flour with 5, 10, 15 and 20 percent multigrain mix (MGM) prepared by combining soybean, oats, fenugreek seeds, flaxseed and sesame seeds on rheological and bread-making characteristics of wheat flour. Addition of 20 percent MGM in wheat flour brought about significant improvement in the dough strength and overall quality of the bread ^[6]. Similarly in a study in 2010 for bread making by addition of soybean flour at 30 percent level into wheat flour and observed that addition of soybean flour in wheat flour was highly acceptable and also obtained higher nutritional value ^[14]. In a study in 2011 different multigrain blends of wheat, mungbean, sorghum, barley, corn (50:20:15:10:5) and flaxseeds at one percent to produce instant multigrain porridge was developed. The results suggest that nutritionally dense multigrain blends can be acceptable and use as traditional breakfast food (porridge) ^[3].

CONCLUSION

Results of this research study showed that , mean sensory scores for overall acceptability was highest for Variation III and fell under the category of "Excellent". It can be concluded that among all the variations, Variation III (Wheat: 60% Defatted Soy flour + Bengal gram: 20% Millets: 20%) was found to be more acceptable than others and selected by the panel members and has significant higher mean scores for appearance (4.36), color (4.28), flavor(4.28), texture(4.28), overall acceptability (4.4).

The Standardized low gluten value added multigrain flour in this study is low in gluten, high in protein, rich in antioxidants, has good amounts of soluble fiber, isoflavones and these nutrients play very important role in weight management and also help to reduce the risk of obesity related chronic diseases such as Cancer, Type II Diabetes and Cardiovascular diseases. The Standardized low gluten value added multigrain flour has essential nutrients such as Omega-3 fatty acids, many

vitamins and minerals. The innovative standardized low gluten value added multigrain flour with many health benefits is ideal not only for overweight individuals but can also be beneficial for all age groups.

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