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DEVELOPMENT AND EVALUATION OF PROTEIN AND FIBRE RICH NUTRI BAR FOR METABOLIC SYNDROME – STATISTICAL EVALUATION

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ABSTRACT

A transition of disorders has been observed globally, associated with dietary habits and life style changes. Metabolic syndrome is one such disorder which is often found with increasing risk factors like Insulin resistance, Coronary artery diseases, Obesity and etc,. Food habits and physical activity is a major concern in the emerging disorder. Dietary modifications and nutrition intervention has shown significant changes in prevention of risk factors associated with metabolic syndrome. The study aimed to develop a Nutri Bar with ingredients rich in proteins and fibre using standardized trials. The objective of the present study is to utilise high protein and fibre rich ingredients to develop a product and conduct the sensory evaluation and nutrition analysis of the developed product. Based on research studies appropriate functional foods were identified and based on their nutritive value which help in prevention of metabolic syndrome, food ingredients were selected and final product is developed. Sensory Evaluation was done using nine point hedonic scale (1-9 scores) to find out overall acceptability of the products with control product (S1) and products with two variations (S2 and S3). For statistical analysis F- test (ANOVA) was used to find out for overall acceptability which showed a significant difference (F=11.64*). There were no significant changes in appearance between samples. A marked significant difference was seen in Aroma (F =11.84*), Taste (F= 19.13*) and Texture (F=7.04*) values. Hence, S3 sample was found to be predominant and successful combination of product with a shelf life stable and found nutritionally rich. The product developed would replace junk foods and also provide high protein and fibre for metabolic syndrome subjects.

KEYWORDS: Insulin resistance, Coronary artery diseases, Obesity and etc.

INTRODUCTION

Metabolic Syndrome (MetS), a combination of disorders like central obesity (abdominal obesity), Dyslipidaemia, elevated Blood pressure and Hyperglycaemia. Increase in such conditions also elevates the chronic disorders like Diabetes mellitus, Cardio vascular disease, Coronary artery disease, chronic kidney disease, polycystic ovarian syndrome and many other chronic diseases.

Several organizations and Panel groups have proposed criteria for the definition of metabolic syndrome. WHO proposed criteria and definition for metabolic syndrome in 1999, Then National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) in 2000 and International Diabetes Federation (IDF) in 2005. The criterion by IDF is used in present study.

The two main components of metabolic syndrome are insulin resistance abdominal obesity which is integrally involved in its pathogenesis. Diabetes mellitus and Cardio vascular disease is dominating in commonly observed disorders. A change in dietary habits and physical inactivity is equally responsible for increasing prevalence of metabolic syndrome. Adapting westernisation and neglecting the culture of food habits followed in India is found to be major factor for increasing incidence in metabolic syndrome in India. Increased consumption of carbohydrates, fats and fewer intakes of vegetables and fruits is the major concern.

The prevalence of metabolic syndrome to be more prevalent in 41–60 years, with increased risk of developing coronary artery disease. It was also found that high percentage prevalence of overweight and obesity was one of the major driving forces in the

development of metabolic syndrome (Sawant et al., 2011)**.**

There is an alarming rise in the prevalence of Metabolic Syndrome in rural areas that will eventually be reflected in increasing morbidity and mortality from heart disease. There is an urgent need to target interventions to rural women who appear to have the highest prevalence of cardiovascular risk factor (Krupp et al., 2020)

Hence, there is a need for awareness programs and lifestyle interventions for the prevention and control of metabolic syndrome.

Modernisation, change in life style and dietary patterns plays a major role in increasing the incidence of metabolic syndrome. An unhealthy dietary practice is the major concern in the elevating trends of metabolic syndrome and its risk factors. Many studies have been conducted on impact of nutrition intervention in prevention of metabolic syndrome.

High protein weight-reducing diet was associated with greater fat loss and lower blood pressure when compared with a high carbohydrate, high fibre diet in high risk overweight and obese women (Morenga et al., 2011)**.**

A positive association between the prevalence of metabolic syndrome and the dietary pattern was found with non-vegetarian diet pattern than traditional Korean diet pattern or snack pattern especially with male adults (Woo et al., 2014).

Low prevalence of multiple cardiovascular risk factors (smoking, hypertension, dyslipidemias, diabetes and metabolic syndrome) in adolescents and rapid escalation of these risk factors by age of 30–39 years is noted in urban Asian Indians. Interventions should focus on these individuals Gupta et al., 2009).

Saturated fatty acid (SFA) consumption were positively associated with the prevalence of Metabolic Syndrome, independent of total dietary fat, Mono unsaturated fatty acids and Poly unsaturated fatty acids intake. However total dietary fat may modulate the association between SFA and some components of metabolic syndrome, results emphasizing that both the quality and quantity of dietary fat are relevant with MetS and cardio metabolic risk factors (Hosseinpour-Niazi et al., 2015).

Low intake of fruits, vegetables, and higher intake of flesh food and inadequate physical activity significantly associated with the metabolic syndrome risk factors (Verma et al., 2018).

Nuts can positively affect the separate components of metabolic syndrome and could be expected to have a protective effect on the whole metabolic syndrome by improving inflammation, oxidative stress, and endothelial function when compared with of high-carbohydrate meals, nuts have a beneficial impact on postprandial glycaemia and reduce glycaemic excursions. (Figure 1) (Salas-Salvadó et al., 2014).

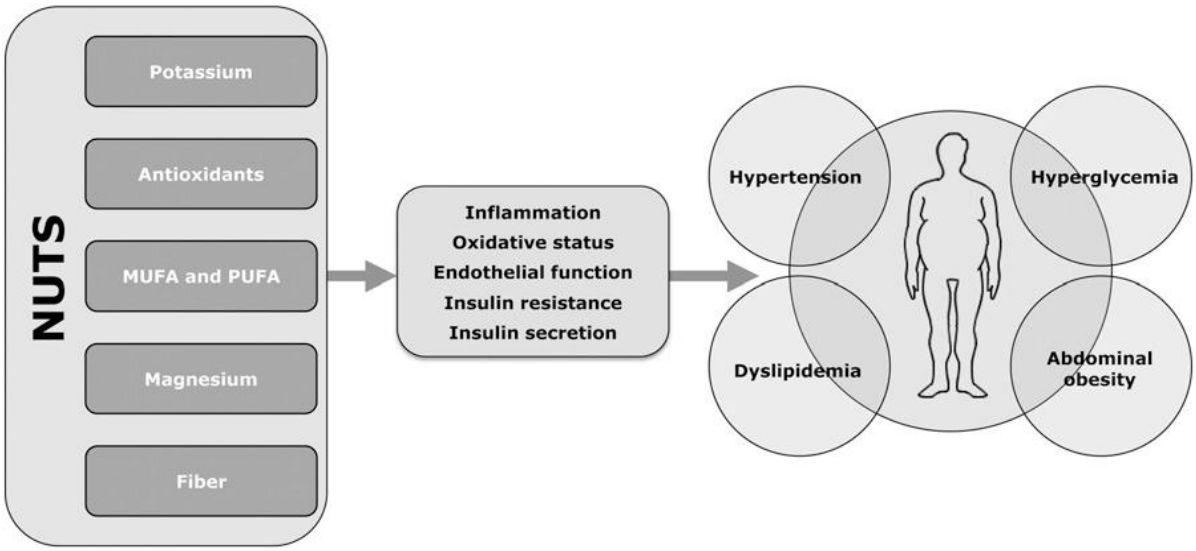

Figure 1: Components and mechanisms by which nuts are associated with metabolic syndrome.

Nut consumption may be beneficial in the prevention of MetS and overweight/obesity. Additional prospective studies are needed to enhance these findings and to explore the metabolic benefits for specific subclasses of nut (Li et al., 2018).

Research on beneficial effects of oats to cardiovascular health through significantly improving of the lipid and glycaemic profiles, being a potential adjuvant in the prevention and treatment of metabolic disorders (Morelo Dal Bosco, 2015)

Study says overall, the limited capacity for conversion to n-3 fatty acids, and the lack of efficacy in ameliorating cardio vascular risk factors and inflammatory markers in man suggests that increased consumption of linoleic acid may be of little benefit in improving health outcomes compared with other dietary interventions (Burdge and Calder, 2006)

Honey enhances insulin sensitivity that further stabilizes blood glucose levels and protects the pancreas from overstimulation brought on by insulin resistance. Further, anti-oxidative properties of honey help in reducing oxidative stress, which is one of the main mechanisms in metabolic syndrome (Ramli et al., 2018)

Honey is a potential agent in reversing metabolic syndrome through its anti-obesity, hypoglycaemic, hypolipidemic, and hypotensive actions. These properties are exerted through the components in honey, like polyphenols, which act as potential lipogenic enzyme inhibitors. Through synergistic actions, these polyphenols can limit weight gain and adipose tissue formation. The antioxidant and anti-inflammatory effects of these polyphenols also prevent endothelial dysfunction and ultimately, hypertension. Honey is shown to improve insulin sensitivity and normalize glucose metabolism despite its carbohydrate content. honey can be used as an adjuvant therapy for prevention of metabolic syndrome in general, by mechanisms such as reducing oxidative stress and inflammation. Thus, it is a beneficial food substance that can be incorporated for the prevention and management of metabolic syndrome. (Hashim et al., 2021)

MATERIALS

Protein and fibre rich nutri bar is been developed. A continues reviews were studied to select the ingredients to form a product. Several trials and variations were performed with inclusion and deletion of ingredients. Finally ideal product with two variations was confirmed. Objective of the study was to find out the acceptance of the product between the two variations along with a control product. Sensory evaluation was conducted between these three products, S1 commercial product (control), S2 product with one variation and S3 product with two variations. Below Figures depicts the different variations of Nutri bar.

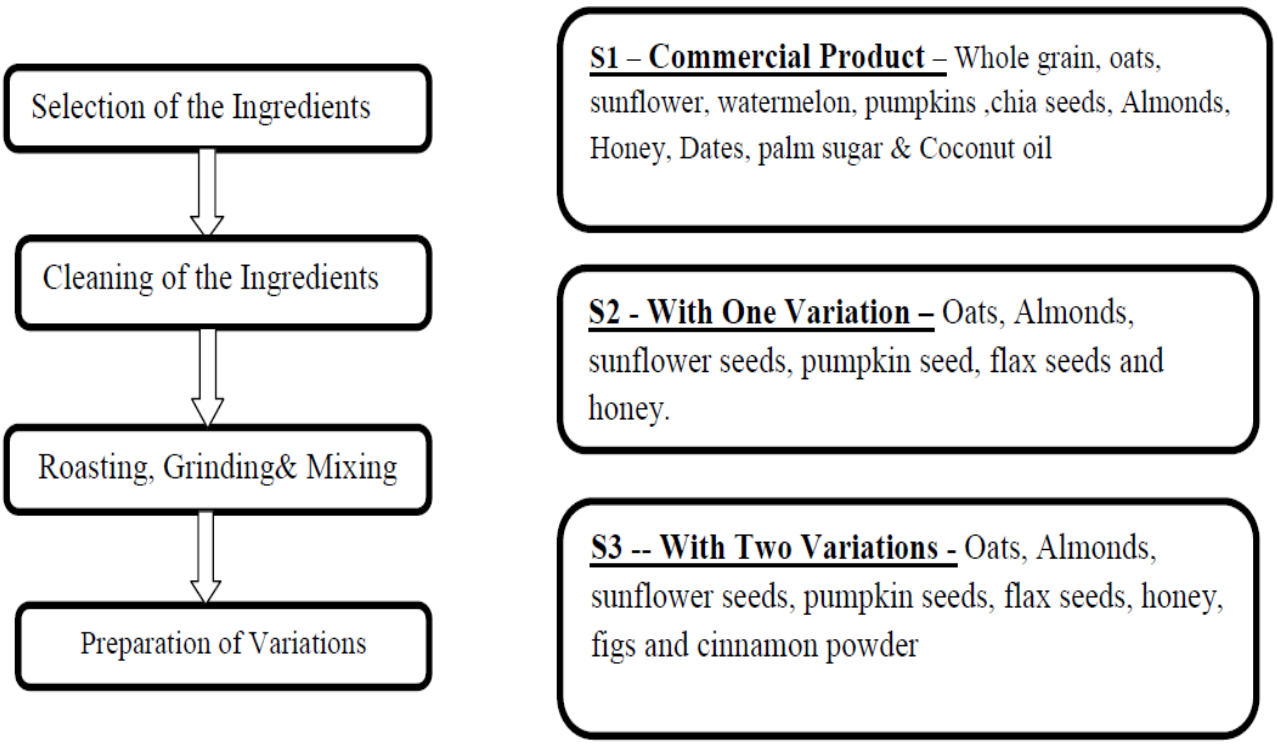

Figure 2: Method and Composition of Product.

All three variations were subjected to.

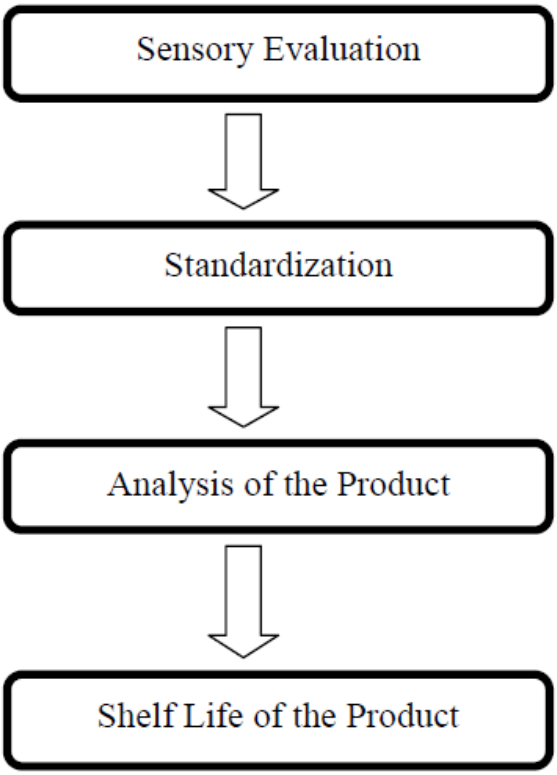

Figure – 3.

METHOD: Product with variations (S1, S2 and S3) as mentioned figure -2 were subjected to Sensory evaluation using 9-point Hedonic scale by 40 health care professionals. Various criteria like appearance, aroma, texture and taste were scored using 1-9 rating. The data obtained was subjected for statistical ANOVA (F-test) to test the significant difference between three samples and finally most accepted was sample with two variations (S3). The best outcome sample S3 subjected for triplicate and statistically established non- significant and ultimately treated as standardised.

Best rated product was analysed for nutritional analysis at laboratory TUV-SUD, Bangalore. Nutrients like 1. Carbohydrate, 2. Protein, 3. Dietary fibre, 4. Energy, 5. Fat and 6. Sugar using different test methods like IS 1656, IS 11062 and FSSAI Manual of Methods. Shelf Life of product was also conducted for different chemical parameters like 1. Acidity Alcoholic, 2. Appearance, 3. Colour, 4. Free fatty acid, 5. Moisture, 6. Odour, 7. Taste, 8. Overall acceptance for 0^{th} Day, 7^{th} Day and 15^{th} Day.

Microbial assay also done using ISO 4833 and IS 21527 test methods. Based on the organoleptic studies, product was concluded as stable for 15 days at 42^{0} C and 85% RH as thumb rule of Q10 theory the sample is interpreted to be stable for 45 days at room temperature.

RESULTS AND DISCUSSION

The obtained data was subjected for appropriate statistical and bio-chemical analysis and finally interpreted in the following Tables.

Table 1: Classification of Respondents by Age and Gender.

Characteristics	Category	Respondents	
		Number	Percent
Age group (years)	21-30	10	25.0
	31-40	19	47.5
	41 and above	11	27.5
Gender	Male	7	17.5
	Female	33	82.5
Total		**40**	**100.0**

N=40

Table-1 depicts about the classification of respondents by age and gender. The result shows that highest of 47.5 per cent respondents are between 31- 40 years of age as compared to 27.5 per cent of respondents found above 41

years and the remaining 25 percent of respondents are of 21-30 years of age. It is evident that 82.5 per cent of respondents are female and 17.5 per cent of respondents are male. (Figure- 4).

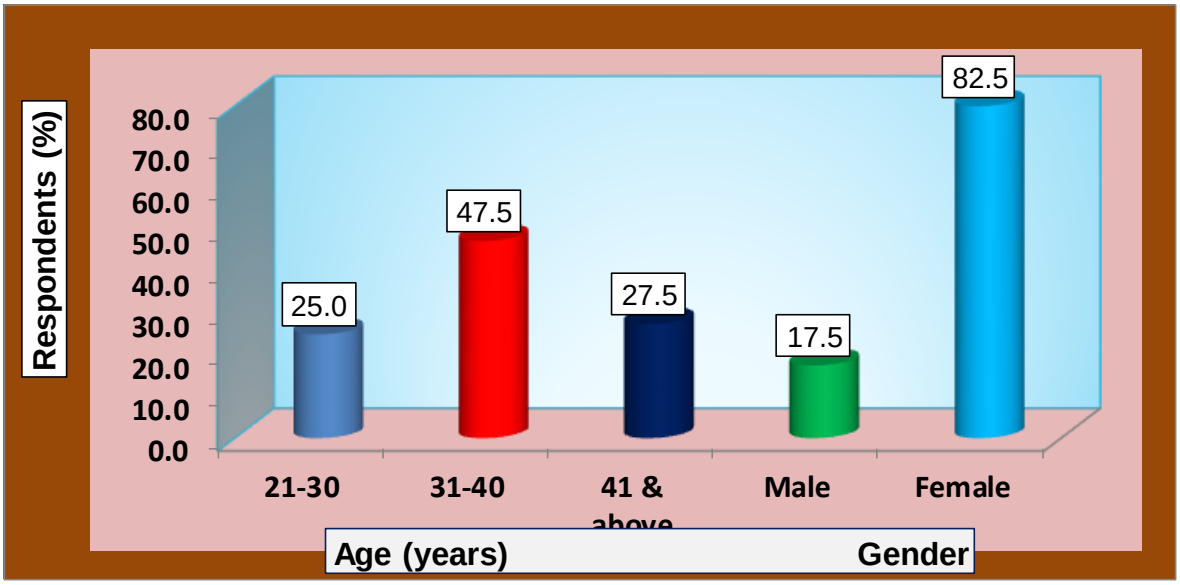

Figure 4: Classification of Respondents by Age and Gender.

Table 2: Classification of Respondents by Socio- Economic Status and Education Qualification.

Characteristics	Category	Respondents	
		Number	Percent
Socio- Economic Status (SES)	Rural	0	0.0
	Urban	40	100.0
Education Qualification	Graduate	16	40.0
	Post graduate	12	30.0
	Professional	12	30.0
Total		**40**	**100.0**

N=40

Table-2 shows that cent percent of respondents were from urban socio economic status. Qualification of respondents depicts that 40 per cent of them were Graduate and 30 per cent of them were Professional and Post Graduate.

Table-3 shows about classification of respondents by their Designation in which it shows that 42.5 per cent were Nurses followed by 32.5 per cent were Doctors and remaining 25 per cent were Dieticians. (Figure-5)

Table 3: Classification of Respondents by Designation.

Designation	Respondents	
	Number	Percent
Doctors	13	32.5
Dietician	10	25.0
Nurses	17	42.5
Total	**40**	**100.0**

N=40

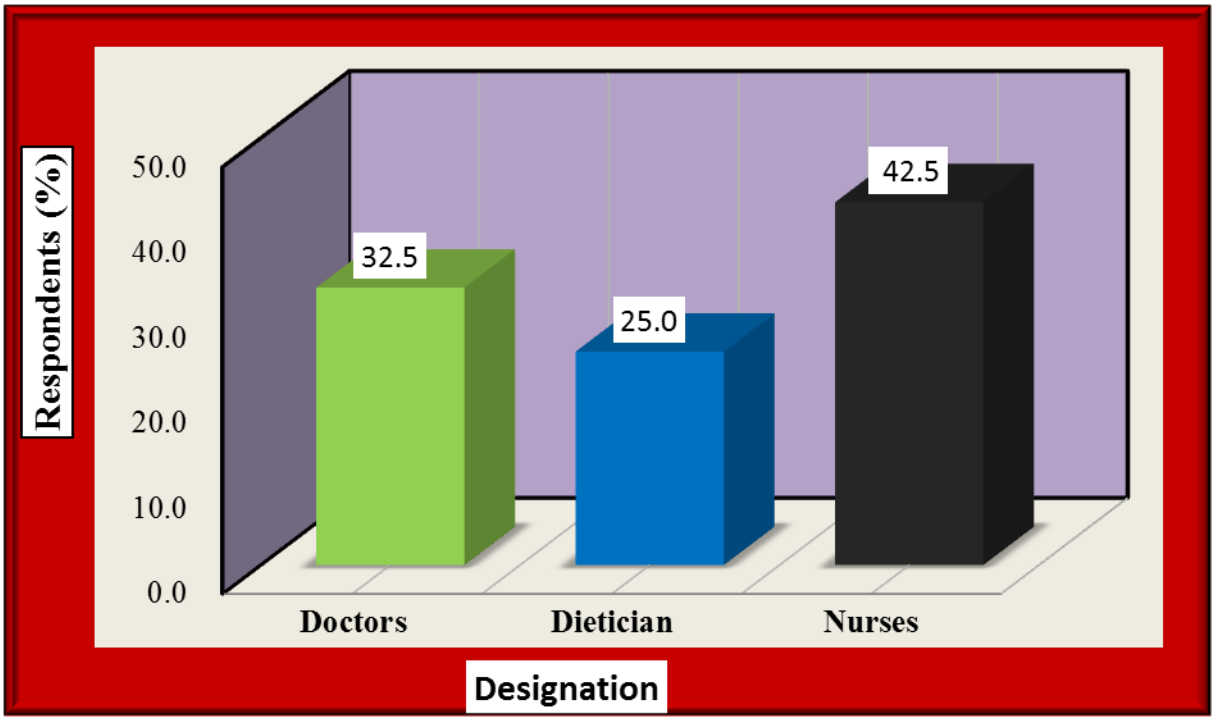

Figure 5: Classification of Respondents by Designation.

Table 4: Overall Mean organoleptic characteristics of Product.

Sl.No.	Variations	Overall Acceptability	
		Mean	SD
1	Sample-1 (control)	6.42 [a]	1.11
2	Sample-2 (with one variation)	7.08 [b]	1.09
3	Sample-3 (with two variation)	7.56 [c]	0.97
	F-Test	11.64*	
	Standard Error (SE)	0.1673	
	Critical Difference (CD)	0.4637	

*Significant at 5% level, Note; Different letter indicate significant between samples.

Table-4 shows Overall Mean scores of organoleptic characteristics of the Product. It shows that the mean acceptability found to be higher in sample 3 (7.56), followed by Sample 2 (7.08) and Sample 1 (6.42). It is evident from the findings that there exist significant difference in the acceptability between samples (F= 11.64*) (Figure 6).

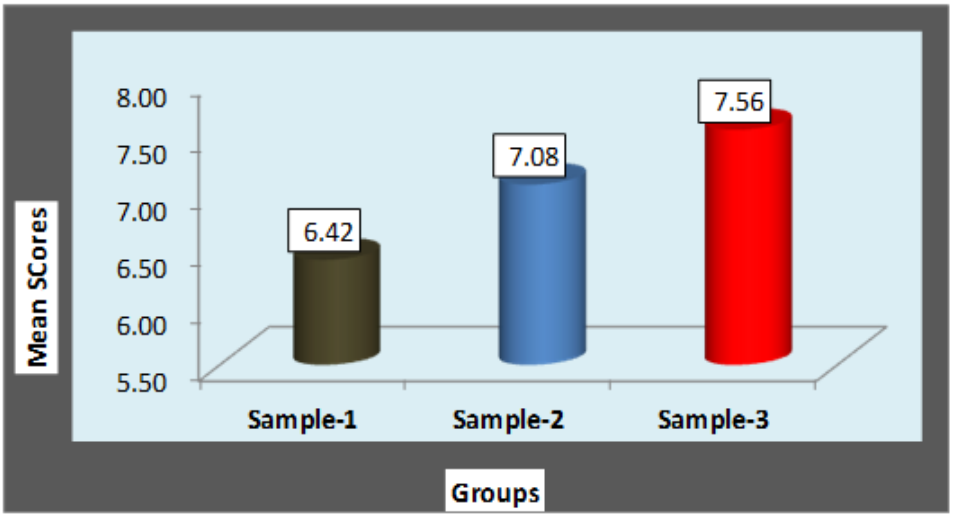

Figure 6: Overall Mean organoleptic characteristics of Product.

Table 5: Aspect wise Mean organoleptic characteristics of Product.

Sl. No.	Sample	Aspect wise Acceptability							
		Appearance		Aroma		Texture		Taste	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	Sample-1	6.98 [a]	1.21	6.00 [a]	1.48	6.58 [a]	1.41	6.13 [a]	1.40
2	Sample-2	7.00 [a]	1.18	6.88 [b]	1.45	6.95 [b]	1.50	7.48 [b]	1.15
3	Sample-3	7.23 [a]	1.29	7.50 [c]	1.18	7.70 [c]	1.16	7.80 [c]	1.29
F-Test		0.51 [NS]		11.84*		7.04*		19.13*	
Standard Error (SE)		0.1939		0.2179		0.2159		0.2032	
Critical Difference (CD)		-		0.6040		0.5985		0.5633	

N=40

*Significant at 5% level, NS: Non-significant

Note ; Different letter indicate significant between samples

Table-5 indicates the aspect wise mean organoleptic characteristics of product. The result reveals that sample 3 found to be best preferred acceptability compared to sample 1 and sample 2 with respect to Appearance (7.23), Aroma (7.50), Texture (7.70) and Taste (7.80). Further it is evident from the findings that there exists significant difference in the mean acceptability between three samples under study in reference to all the three organoleptic characteristics ($p< 0.05$) except appearance ($p> 0.05$). (Figure 7).

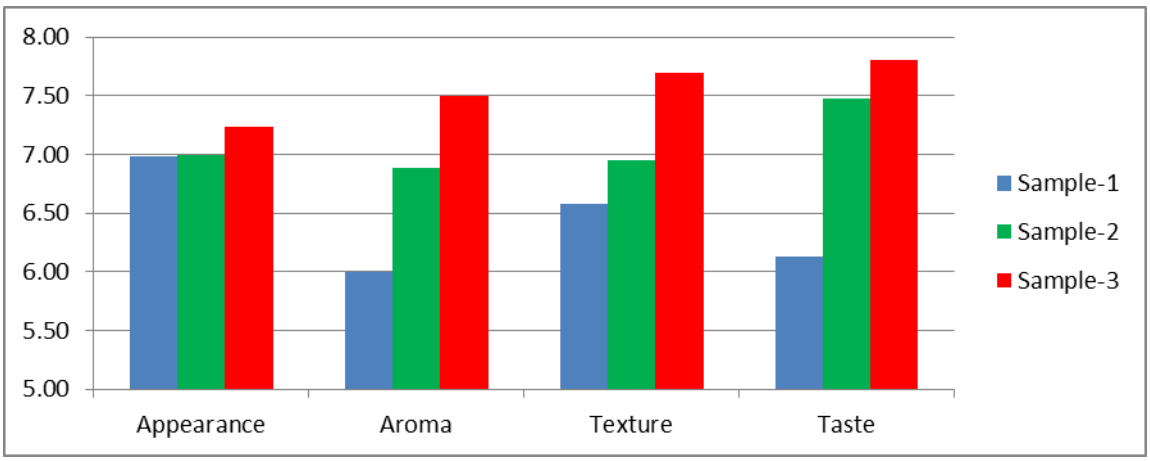

Figure 7: Aspect wise Mean organoleptic characteristics of Product.

Table 6: Food Analysis Report.

Sl. No	Parameters	0th Day	7th Day	15th Day	Method
1	Acidity Alcoholic (%)	0.09	0.12	0.14	FSSAI Manual of Methods
2	Appearance	Pale Brown coloured solid	Pale Brown coloured solid	Pale Brown coloured solid	Visual Examination
3	Colour	Pale Brown	Pale Brown	Pale Brown	Visual Examination
4	Free fatty Acid	0.07	0.09	0.1	FSSAI Manual of Methods
5	Moisture(%)	10.25	10.39	10.57	FSSAI Manual of Methods
6	Odour	Characteristics	Characteristics	Characteristics	Sensory Evaluation
7	Taste	Characteristics	Characteristics	Characteristics	Sensory Evaluation
8	Overall Acceptance	Good	Good	Good	Sensory Evaluation

Table -6 depicts Food Analysis report as given by lab TUV- SUD, Bangalore. Food analysis was done for 8 parameters like Acidity Alcoholic percentage, Appearance, Color, Free Fatty acid, Moisture percentage, Odor, Taste, and Overall acceptance for 0th day, 7th Day and 15th day using Food Safety and Standards Authority of India Manual methods, Visual Examination and Sensory Evaluation. Overall acceptance was found to be good and stable shelf life for 15 days.

SALIENT FEATURES OF THE STUDY: The study is concluded statistically proven that majority of respondents found in the age group of 31- 40 years, urban location, graduates and nurses. The overall mean acceptability found to be highest in sample 3 (7.56) followed by sample 2 (7.08) and control (6.42) establishing statistical significant difference ($F= 11.64*$). It can be concluded that sample 3 established the highest mean acceptability in the entire three organoleptic characteristic with statistical significance ($p< 0.05$). The

overall acceptability was found to be good as reported in food test report and nutritionally rich in 1. Energy- 460 Kcal, 2. Protein – 15g, Dietary Fiber – 14.5g, Carbohydrate- 50.5 g and Fat – 22g per 100g of the product. This result indicates that product is nutritionally rich and could be a supplement snack for individuals who are on weight reduction. Oats, almonds and different seeds used in product would provide good protein and fiber which helps in reducing hyperglycemia and dyslipidemia and systolic and diastolic blood pressure variations. Also honey as a special value added ingredient in product enhances the taste and acts as an anti-oxidant, antiobesity, hypoglycemic, hypolipidemic and hypotensive property. Product would be good combination of protein and fiber which is best supplement for reducing metabolic syndrome criteria and its complications. Product is developed in the bar form as it is ready to eat and can be replace any junk food.

CONCLUSION

Thus the developed product would be a great choice as supplement for protein and fiber for all age group (Adolescent to Adult group). As metabolic syndrome being more prevalent and considered to be a global burden and affecting health, productivity and economy, as a preventive nutrition care this product S3 would be a healthy and nutritious supplement for metabolic syndrome or any other non-communicable disorders.

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Competing interests: The authors have declared that no competing interests exist.

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