Effect of Addition of Cassava, Ragi and Wheat Flour on Physico-Chemical Properties of Nutri Bar

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doi: 10.48047/ecb/2023.12.si4.918

Abstract

Energy bars are supplemental bars containing high energy foods targeted at people who require instant energy and this type of product can be prepared using different underutilized cereal crops having more nutritional value. The present study was undertaken to see the effect of addition of cassava, ragi and wheat flour on Physico-Chemical Properties of Nutri Bar which was prepared using a mixture of cassava, ragi and whole wheat flour in the ratio of 2:1:1. The developed nutri bar samples were analyzed for nutritional and sensory properties. Nutri bar have become the food choice for many people who find it difficult to consume a full meal. The bars offer a fast, convenient food source that requires no refrigeration and a long shelf life. Cassava is the third-largest source of food carbohydrate in the tropics, after rice and maize and is gluten free. Cassava is a good source of minerals such as calcium, iron and zinc. Physico-chemical analysis of optimized nutri bar showed that carbohydrate, fat, protein, ash, moisture total solid and energy content varied from 63.99-423.68 Kcal, respectively. Samples of optimized treatment were analysed for textural characteristics and it was found that hardness, cohesiveness, springiness, gumminess, chewiness and adhesiveness were 43.12 (N/mm^2), 0.06 (N), 2.18 (m), 5.64 (N), 17.76 (J) and 0.94 (J), respectively. Sensory analysis result showed samples of treatment T_9 scored the highest values in all the parameters of sensory attributes and therefore was considered as optimized product.

Keywords: Formulation, Food composition, Celiac disease, Nutritional value, Chemical properties, Physical properties, Sensory properties.

Introduction

Ready to eat snack and health bars have gained a foot hold in the global market and are in high demand as nutritional supplements for people on the go and weight watchers especially people eating calorie-controlled diets **(Rawat *et al*., 2015).** Most health bar currently in the market are US based and not produced in India. Though a few that are made in India and available in the market have not gained any market popularity or brand value as nutrition health bars **(Dabelea *et al*., 2007).** Cereal bars may be considered a good source of carbohydrate and may promote the recovery of energy following exercises when used as a food supplement or as "portable nutrition" **(Brito *et al*., 2005).** However, people on diet and individuals with nutritional problems or irregular meals can also utilize energy bars for nourishment. Snack bars are highly versatile foods and confer nutritional benefits (high-quality proteins, polyunsaturated fatty acids, minerals, vitamins, and fibers) apart from necessary energy. They are convenient and are available in easy to store and carry packages **(Constantin *et al*., 2018)**.

The main aim of the snack and energy bar is to satisfy hunger, replace a meal, and provide essential nutrition i.e. the protein, carbohydrates, fats and vitamins required by the body in a small package. Also being convenient and handy is its all-time unique selling feature. Energy bars are healthy, convenient and proportioned snacks, providing nutrients in adequate amounts **(Ho *et al*., 2016).** Also known as snack bars, they are usually marketed as 'ready-to-eat' formulations that are based on whole cereal grains **(Svisco *et al*., 2019).** Energy balance is an important factor in sustaining training load and maintaining high performance during exercise **(Tanskanen *et al*., 2012)** because of that, maintaining the energy intake is the best way to increase performance based on that activity has been found to have an influence on physical activity especially to boosting the high energy intake when exercise. Energy bars are supplemental bars containing high energy foods targeted at people who require quick energy. Nowadays, this product is the target marketing for several industries to increase their selling product. A lot of athletes put in this product on their diet because it can be travel easily, provide a quick snack **(Manore *et al*., 2006)**.

Cassava originated in the New World. Today it is a staple food and animal feed in tropical and subtropical Africa, Asia, and Latin America, with an estimated total cultivated area greater than 13 million hectares, of which more than 70% is in Africa and Asia. Approximately, 500 million people depend on it as a major carbohydrate (energy) source, in part because it yields more energy per hectare than other major crops. Cassava is grown predominantly by small-scale farmers with limited resources in marginally fertile soils; Cassava has been targeted for bio fortification because of its unique geographical distribution and its importance as a staple food. **(El-Sharkawy *et al*., 2003).** Cassava flour is considered a caloric food due to its starch content. According to the food composition table of **Franco (2007)**, cassava flour may generate 350 kcal per 100 g. It also contains small amounts of protein, calcium, phosphorus, sodium, and potassium **(Duarte *et al.*, 2008).**

Cassava plays an important role in food, both for food security and for multiple commercial and industrial uses **(Biaou *et al.*, 2006, Somendrika *et al.*, 2016).** It is the third largest food calorie source in the tropics, behind rice and maize **(FAO, 2008) (Somendrika *et al.*, 2016) (Bahati Kavange *et al.*, 2017).** Person diagnosed with celiac disease or any other gluten-based allergies can find relief by consuming foods formulated from cassava flour. In the food industry, it is common to mix different ingredients with different nutritional and functional properties **(Gomes *et al*., 2009)**. **Mahanna et al. (2009)** evaluated the parameters used by consumers when choosing cereal bars and found that consumers pay special attention to the caloric value and the type of ingredients used in the food. These authors confirmed that taste is the most important sensory attribute to consumers **(Degaspari et al., 2008)**.

It is also possible to replace the cereals and their derivatives with gluten free ingredients enabling the bars to enter the specific food market for celiac disease patients, in addition to the regular fast food, nutrition, and energy food market. Celiac disease is a type of intolerance to gluten which affects between 0.5 and 1.0% of world’s population **(Castro-Antunes *et al.*, 2010)** and is characterized by partial or total atrophy of intestinal mucosa that results in nutrient malabsorption. The solution is the permanent withdrawal of gluten from the diet, which leads to the exclusion of cereals such as wheat, rye, barley, malt, and oats **(Sdepanian *et al*., 2001)**. Cassava flour-based bars could also benefit consumers with celiac syndrome since they do not contain gluten. Among the advantages of cassava flour-based bars is the modernization and expansion of cassava flour market since the bars provide a nutritionally balanced food by the addition of wheat flour and ragi flour.

Finger millet is commonly known as ragi (Eleusine coracana). It is also known as African millet and Black millet. India is one of the leading countries with respect to production and utilization of ragi. It is extensively grown in Karnataka, Tamil Nadu, Andhra Pradesh, Bihar, Maharashtra and Gujarat. Finger millet needs a fairly high rainfall, but will tolerate poor soil. Finger millet is especially valuable as it contains the amino acid methionine, which is lacking in the diets of hundreds of millions of the poor who live on starchy staples such as cassava, plantain, polished rice or maize meal. The finger millet proteins are rich in two of essential amino acids (methionine and tryptophan) and substantial amounts of the essential amino acids, except lysine **(Fernandez *et al.*, 2003)**. Finger millet is a good source of iron and calcium which especially relevant to populations inhabiting northern Nigeria where the high incidences of prevalence of iron deficiency anemia in pregnant women **(Vander Jagt *et al.*, 2007)** and calcium deficiency rickets in young children **(Thacher *et al.*, 2000; Vander Jagt *et al.*, 2001)**. Finger millet contains about 5–8% protein, 1–2% ether extractives, 65–75% carbohydrates, 15–20% dietary fiber and 2.5–3.5% minerals **(Chethan *et al.*, 2007)**

Till date no studies had been reported where cassava, ragi and wheat flour has been used to prepare nutri bar and considering the health beneficial properties of the above mentioned ingredients, the present study was undertaken to prepare nutri bar using a combination of cassava flour, ragi flour and wheat flour and subsequently analysing the products for physical, chemical and sensory characteristics.

2 Materials and methods:

2.1 Procurement of Materials and formulation of treatments

Good quality wheat flour (*Triticum aestivum*), cassava flour (*Manihot esculenta*), ragi flour (*Eleusine coracana*), Bengal gram flour, jaggery and flax seed were procured from the local Market of Prayagraj. Honey was procured from Dabur india.

Ten treatments were formulated viz., T0, T1, T2,T3,T4,T5,T6,T7,T8 & T9. In all the treatments honey was added 10 %, Bengal gram flour was added@ 4 %, flaxseed was added@ 1 % , jaggrey was added@ 15 %. The variation in cassava flour, ragi flour and wheat flour are presented in table 1

Table 1: Variation in different flour for Formulation of Nutri bar

Ingredients	Treatments									
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9
Wheat flour	100	90	85	80	75	70	65	60	55	50
Cassava flour	0	5	10	10	15	15	20	20	25	25
Ragi flour	0	5	5	10	10	15	15	20	20	25

2.2 Preparation of bars:

Nutribar samples were prepared as per the procedure of **Shinde *et al.* (2019)**. Treatments were formulated where wheat flour was added 50% cassava flour was added (25%) and ragi flour was added

(25%). The calculated amount of wheat flour, cassava flour, ragi flour, sattu and honey were taken and all the ingredients were mixed thoroughly.Pre heat the pan at 160℃ for 10 minutes and roasted all the gently until golden brown colour occurred. Jaggery syrup was prepared with 40 ml of boiling water at 105℃ temperature to get thick consistent syrup with 90-92 brix. Syrup and dry ingredients were mixed to make smooth dough ***Narayan et al*. (2023)**. Dough was placed in stainless-steel tray to make it cool for 5 minutes. Rectangular bars were cut in rectangular shape (8.5 cm× 2.5 cm× 2 cm) approximate weight 40 g per piece. Chocolate syrup was spread on it and garnished with flaxseed. Bars were packed in silver foil and stored in a cool and well-ventilated place.

2.3 Physical and chemical analysis:

The samples were analysed for moisture, ash, crude fat, protein and carbohydrate as per the procedure of AOAC, 2000. Textural properties were analysed using Texture Analyser where texture attributes like hardness (N/mm^2), adhesive force (g), springiness (mm), cohesiveness (N), gumminess (N), chewiness (kg) were calculated.

2.4 Sensory Evaluation

Nutri bars samples were served to the panellists and they evaluated the product for color and appearance, flavour, body and texture and overall acceptability of the product on the basis of 9 point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely).

2.5 Statistical analysis

The experiments were conducted in triplicate and the data were analysed by MS Excel 2010.

Results and discussion

The product was analysed for proximate composition of which includes moisture, ash, fat, protein and carbohydrate content and is presented in Table 1.1.

Table 1.1: Proximate composition analysis of Nutri bar

Treatment	Carbohydrate (g/100g)	Fat (g/100g)	Protein (g/100g)	Ash (g/100g)	Moisture (g/100g)	Total Solid (g/100g)	Energy (Kcal)
T_0	63.99	5.18	5.78	1.36	23.69	76.31	421.63
T_1	65.11	5.71	6.08	1.38	21.72	78.28	421.76
T_2	66.25	6.18	6.48	1.62	19.47	80.53	421.89

T_3	66.38	6.47	6.71	1.65	18.79	81.21	422.02
T_4	67.32	6.61	6.81	1.66	18.63	82.4	422.12
T_5	67.37	6.73	7.02	1.66	17.22	82.78	422.38
T_6	68.28	6.73	7.03	1.67	16.29	83.71	422.62
T_7	68.40	6.73	7.45	1.71	15.72	84.29	422.79
T_8	68.77	6.84	7.57	1.71	15.2	84.89	423.12
T_9	68.83	6.90	7.71	1.72	14.84	85.16	423.68

Effect of variation of wheat flour, ragi flour and cassava flour on carbohydrate content of nutri bar

Carbohydrates in the nutri bar was mostly contributed by cassava flour and ragi flour. It was observed that with the incorporation of cassava and ragi, there was a slight increase in the total carbohydrate content ***mall et al.*, (2022)**, Carbohydrate content of nutribar samples prepared in different treatments are presented in Table 1.1.The total carbohydrate content was found to be 63.99 g/100 g nutri bar in the control sample, while the highest carbohydrate content was at 68.83 g/100 g of nutri bar, found in treatment (T9) which was made with wheat flour, ragi flour and cassava flour in ratio of 2:1:1. It was concluded that there was a significant increase in the total carbohydrate content of the treatments enriched with cassava and ragi flour.

Effect of variation of wheat flour, ragi flour and cassava flour on fat content of nutri bar

Fat content of nutribar samples prepared in different treatments are presented in Table 1.1.It was noticed from Table 1.1 that the fat content of the nutri bar was slightly increased with the variation in cassava flour and ragi flour. Results showed that control sample contained fat content is 5.18 meanwhile treatment T9 contained 6.90 g fat/100 g of nutri bar. **Chourase *et al.*, (2023)**, It was also observed that there was significant difference between the fat content of the control sample and the treatments, it is worth noting that cassava flour and ragi flour contributes small amounts of abundantly nutritious fat. According to **Gopalan *et al.*, (2004)**, wheat and ragi contains 1.7 and 1.3 g fat/100 g, respectively.

Effect of variation of wheat flour, ragi flour and cassava flour on protein content of nutri bar

Protein content of nutribar samples prepared in different treatments are presented in Table 1.1. From the present study, it has been observed that there was a sharp increase in the protein content of the nutri bar with the incorporation of cassava flour and ragi flour. The control sample was found to have 5.78 g protein/100 g nutri bar (Table 1.1). In the treatment T9 of the bar containing 7.71 g cassava flour and ragi flour / 100 g sample. Sattu and flax seeds, which are reasonably good sources of protein, also contributed to its increase in the nutri bar.

Effect of variation of wheat flour, ragi flour and cassava flour on ash content of nutri bar

Ash content of nutribar samples prepared in different treatments are presented in Table 1.1.Several essential minerals are available in Cassava and ragi. A subsequent increase in the ash content confirmed the increase in mineral content. The ash content of the control sample was 1.36 g/100 g sample; the range of the ash content in the treatments lied between 1.36-1.72 g/100 g sample. The mineral content of the nutri bar enriched with Cassava significantly improved. A substantial increase in the mineral content in extruded snacks prepared with the incorporation of Cassava was reported ***NARAYAN et al.*** **(2023)**.

Effect of variation of wheat flour, ragi flour and cassava flour on moisture and total solids content of nutri bar

Moisture content of nutribar samples prepared in different treatments are presented in Table 1.1.The moisture content of the nutri bar was subject to the quantity of water used in jaggery syrup added, which helped as a binding agent in the nutri bar. It was noticed that the highest moisture content, 23.69 g/100 g of control nutri bar, whereas, treatments containing 14.84-21.72 g / 100 g of nutri bar. It was also noted that the addition of Cassava did not affect the moisture content of the nutri bar ***NARAYAN et al.*** **(2022)**.

The result showed in Table 1.1 that the total solid content of the nutri bar was slightly increased with the variation in cassava flour and ragi flour. Results showed that control sample contained fat content is 76.31 meanwhile treatment T9 contained 85.16 g fat/100 g of nutri bar. It was also observed that there was significant difference between the total solid content of the control sample and the treatments, it is worth noting that cassava flour and ragi flour contributes small amounts of abundantly total solids ***Faiz et al.*** **(2022)**.

Effect of variation of wheat flour, ragi flour and cassava flour Energy content of nutri bar

The energy (Kcal) of the nutri bar in this research varied between 421.63-423.68 kcal/100g (Table 1.1). The energy from this study was slightly higher than other studies on cereal bar from cereals. On the other hand, many studies reported lower gross energy from cereal bar made with Baru pulp and almond (337.37 kcal/100g), cereal bar made with Macauba nuts (348.66 kcal/100g), cereal bar with cream nut, Sterculia seed, Tonka bean, and pineapple (407.50–434.00 kcal/100g), gluten-free cereal bar with pseudo-cereal cultivars (180.39 kcal/100g) **(Agbaje *et al.*, 2016; Carvalho, 2008; Lima *et al.*, 2010)**. This can be attributed to the high content of puffed rice and fruit contents which led to a higher cereal to fruit ratio **(Agbaje *et al.*, 2016)**. Thus, the cereal bar composed of puffed rice, fruits, and sweetener can be considered a high gross energy value cereal bar.

Effect of variation of wheat flour, ragi flour and cassava flour on textural characteristics of nutri bar

Texture is one of the most important parameters that determine product quality. The instrumental determinations of texture profile analysis of nutritional bar samples are shown in Table 3.2.

Table 1.2: Texture profile analysis (SI unit) of Nutri bar

Treatment	Hardness (N/mm^2)	Cohesiveness (N)	Springiness (m)	Gumminess (N)	Chewiness (J)	Adhesiveness (J)
T_0	9.03	0.23	4.61	1.01	9.04	0.13
T_1	13.87	0.20	3.85	2.78	13.01	0.35
T_2	25.89	0.17	3.44	3.67	14.01	0.44
T_3	26.34	0.17	3.31	3.96	14.23	0.48
T_4	33.23	0.16	3.16	4.22	14.96	0.56
T_5	33.56	0.15	3.03	4.86	15.46	0.78
T_6	39.34	0.13	2.47	4.89	15.96	0.82
T_7	39.45	0.12	2.47	5.22	16.94	0.84
T_8	43.06	0.11	2.22	5.31	17.32	0.90
T_9	43.12	0.06	2.18	5.64	17.76	0.94

It is noted that the hardness values (N/mm^2) of the nutri bar samples which recorded the significantly highest hardness in treatment T9 is 43.12 than treatment T1 is 13.87, while sample T0 is 9.03 was significantly the lowest one. **Samakradhamrongthai *et al.* (2021)** reported that high-energy cereal bar had highest hardness, and this could be related to the migration of moisture among the carbohydrates (like starches, pectin, sugars, and maltodextrin and the proteins. Cohesiveness (N) was found to be significantly highest ($P \leq 0.05$) in control T0 is 0.23 and treatment T1 is 0.20 than Treatment T9 is 0.06. Springiness (m) was found to be significantly highest ($P \leq 0.05$) in control T0 is 4.61 and treatment T1 is 3.85 than Treatment T9 is 2.18. **Roy *et al.* (2021)** Gumminess (N) was found to be significantly highest ($P \leq 0.05$) in treatment T9 is 5.64 than treatment T1 is 2.78, while control T0 is 1.01 was significantly the lowest one. The evaluation of the texture attribute based on chewiness confirmed that the nutri bar were softer, resulting in higher scores. This softening of the nutri bar was the first sign of bar disintegration ***NARAYAN et al.* (2022)**. It was possible to successfully re-shape or restructure the broken bar by adding more water or commercial glucose syrup as a binder and recompressing the mixture. Result showed chewiness (J) of the nutri bar samples which recorded the significantly highest chewiness in treatment T9 is 17.76 than treatment T1 is 13.01, while control T0 is 9.04 was significantly the lowest one. Adhesiveness (J) were found to be significantly highest ($P \leq 0.05$) in treatment T9 is 0.94 than Treatment T0 is 0.35 and control T0 is 0.13.

Effect of variation of wheat flour, ragi flour and cassava flour on sensory attributes of nutribar

Sensory evaluation such as color, taste, odor, texture, overall acceptability of nutri bar are presented in Figure 3.3. Scores of sensory attributes like colour, aroma, taste, texture and overall acceptability on a 9—point Hedonic scale are being presented in Tables 1.2, where 9 was given for liked extremely in all respects and 1 for highly disliked samples.

Fig 1: Sensory Evaluation of Nutri bar

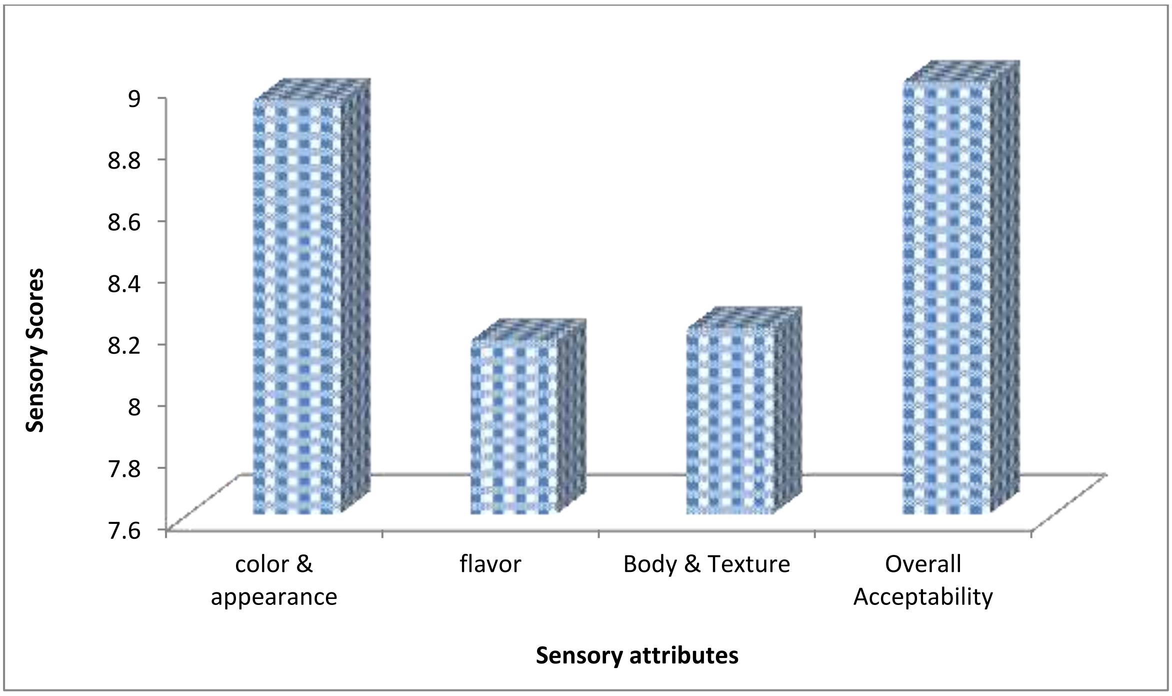

Fig. 1

In this study, it was found that the colour and appearance of the nutri bar was perceived to be significantly different ($p<0.05$) from that of the control sample (fig 1). It was also noticed that bar with higher content of cassava and ragi had a stronger appeal than those with considerably lesser amounts. Also, the sensory score of the treatments significantly varied ($p<0.05$) from the control sample. . The following sensory attributes, namely taste, colour, texture, appearance and overall acceptability were assessed on the cereal bar samples. A 9-point hedonic scale with 1= extremely dislike, 5 = moderately liked and 9 = like extremely was used **A.Stone *et al,. (*1993).** Study for sensory evaluation reported that taste triumphs over health in case of products made for the target population comprising of children and young adults. The taste is a more powerful determinant than health-promoting factors for product selection. The better the flavor, the more likely it is for the product to gain the acceptability of children. It was observed in the study that treatments T9 had sensory scores of flavor at 8.16, whereas control sample of nutri bar recorded 6.48 ***Babu et al, (*2020).** This could again be attributed to the masking of bitterness and after flavor of cassava and ragi by the jaggery used in the making of the nutri bar. The acceptance of novel products also depends on the level of bitterness or any after flavor.

Body and texture of the nutri bar were mostly affected by cassava flour and ragi flour used for making the bar. It was observed that the texture of the bar in terms of hardness was primarily affected by the increase in proportion of cassava flour and ragi flour. The treatment that was most acceptable in terms of body and texture was T9 and scored 8.20 and treatment T0 with a sensory score 6.40. This can be attributed to the balanced ratio of cassava flour and ragi flour in the formulation of the nutri bar. The results are not also far from what obtained in the studies about food bar made from whole flour from a new cultivar of Amaranth **L. M. Pagamunici *et al,* (2014).** the scores for appearance ranged between 7.34-7.64, texture, 6.88-7.38, and overall acceptance, 6.91-7.38.

All samples had mean scores that ranged from 'like moderately' to 'like extremely'. Treatments did not fall into the category of dislike or neither like nor dislike. Treatment T9 had the highest overall acceptability at 9.0, which did significantly vary ($p<0.05$) from the control sample.

Conclusion

From the results obtained in the study, it can be concluded that the use of wheat (50%) flour, cassava flour (25%) and ragi flour (25%) materials as ingredients for energy bar production improved the nutritional values of this snack food. The developed bar can be considered a healthier alternative to several high carbohydrates (cassava flour and ragi flour) based snacks, as it has the potential to supply energy and nutrient in a compact and digestible manner. The cassava flour and ragi flour-based nutri bar formulated with wheat flour provided nutritionally balanced 100 g bar that presented physical, chemical, and sensory scores under ambient conditions in an artificially illuminated room. As for the nutritional value of the bar, they can be considered as a well-balanced snack.

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