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Physico-chemical Properties and Cost Analysis of Jaggery based Salubrious Snack Bar

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ABSTRACT

Background: Snack bars are the one which helps to satisfy the appetite of the individual were often consumed in between the main meals. Optimum nutrition is the basic necessity for the good health, intake of balanced diet provides all the necessary nutrients that are required.

Methods: In this laboratory experiment conducted during 2019-2020 at in Post Graduate and Research centre, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad eight different combination of snack bars were developed by using 35% jaggery concentration. Pineapple, beetroot and dates were in varied concentrations whereas, pumpkin seeds, oats and groundnuts were kept constant.

Result: The combination with equal amounts of pineapple, dates and less amount of beetroot has highest acceptability followed by bar with high amount of pineapple> dates> beetroot. The lowest organoleptic parameters were for bar with highest amount of pineapple and equal amounts of beetroot and dates followed by highest amount of pineapple>beetroot>dates. The nutritional properties were good for developed snack bar compared to control where its moisture was 6.98±0.03%, ash was 1.57±0.02%, protein was 13.47±0.00%, fat was 6.36±0.14%, crude fibre was 8.40±0.00%, carbohydrate was 63.22±0.06 and energy was 357.24±0.13. It was shown that the 35% of jaggery combination has the best acceptance when compared to the other combinations. They had the good nutrient composition and are cost effective.

Key words: Beetroot, Cooking parameters, Dry dates, Fruit bars, Functional properties, Geometric properties, Nutritional properties, Physical properties, Pineapple, Sensory evaluation, Snack bars.

INTRODUCTION

Food consumption mainly depends on the preference and convenience, with tastier foods being energy dense and lacking nutrients in them. The nutrient rich foods were more costly than energy dense foods. The consumption of foods depends on its price, with fruits and vegetables being nutrient rich and low energy dense foods (Darmon *et al.,* 2005).

Socio-economic status effects the individuals healthy eating choices, low-income groups have greater tendency to have unhealthy eating practices. The access for the healthy foods was low for them due to their income and location. Motivational, psychosocial and life style practices are the major barriers for the consumption of the healthy foods (Dibsdall *et al*., 2002).

Nutrition plays a crucial role in lowering the risks of chronic diseases through diet. Functional foods were necessary for mental and physical well-being of the individuals. Single micronutrient incorporated into the functional foods helps to improve the immunocompetence similar to that of pre and probiotics. Selenium, vitamins C, E has more effects on the immunity levels by decreasing the levels of infections, diseases and tumours (Varela *et al*., 2002).

The consumption of the snack bars has been increased due to the life style modifications. The main aim of the energy and snack bars is to replace the meal, provide nutrients and to meet their satiety levels. The snack bars were convenient, easy to carry and portable (Hogan *et al*., 2012).

Pineapple had high contents of vitamins, minerals, fiber and enzymes. Pineapples were a good source of vitamin-C, cholesterol free and good source of manganese that is needed for the body to build bone and connective tissues. Pineapple also strengthens the bones of older people. The juice also helps to kill intestinal worms and helps to relieve intestinal disorders, phytochemicals in the fruit stimulate the kidneys and aids in removing toxic elements in the body (Hoosain *et al*., 2015).

Chenopodiaceae family has an important biennial plant beetroot (*Beta vulgaris*) betalins were used as the natural food pigment which are stable at pH between 3-7 (Roy *et al*.,

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2004). It has beneficial effects on the health due to the presence of nitrogen compounds betalins and the antioxidants and radical-scavenging activities which reduces the ovarian and bladder cancer (Singh and Hathan, 2014).

Oats (*Avena sativa* L.) contain glucans and dietary fibre which helps to maintain the blood glucose levels in the diabetic individuals. β-glucan which plays an important role in lowering the blood cholesterol levels (Chitkara *et al.*, 2017).

Dates has high amount of carbohydrates and low in protein, bars were made with dates paste, almonds and oats which were fortified with and skimmed milk and sesame seeds (Nichols and Cheryan, 1982). The protein content in the fortified bar was more when compared to that of the control bar according to RDA, there was an increase of 4.1% protein decrease of 0.5% of energy (Anon, 1992). Due to its acceptability the demand for the bars has been increased in the Arab countries (Al-Hooti *et al.*, 1997).

Pumpkin is good source of the high dietary fibre, protein along with polyunsaturated fats which reduces blood glucose and cholesterolemia. The bars prepared with the pumpkin seed flour has high dietary fibre and protein compared to the control and the sensory parameters were high for the bar with pumpkin seed flour (Silva *et al.*, 2014).

MATERIALS AND METHODS

Location of work

Post Graduate and Research Centre, Professor Jaya Shankar Telangana State Agricultural University, Rajendranagar, Hyderabad.

Procurement of raw materials

Pineapples, beetroot, dates, jaggery, oats, pumpkin seeds, groundnuts and honey were procured from the local markets and rythu bazar of Hyderabad.

Preparation of fruits and vegetables

The osmo-dehydrated pineapple, dried beet and soaked dried dates were prepared as given by (Sree *et al.*, 2020).

Standardization of fruit bars

Bars were standardised with 35% concentration of jaggery along with different combinations of pineapple, beetroot and dates whereas 20% groundnuts, 5% oats and 5% pumpkin seeds were kept constant. The process for preparation of bar is given as flow chart in Fig 1.

Sensory evaluation

The prepared snack bars were evaluated in the sensory booth by the 15 semi-trained panellists in the Post Graduate and Research Centre, PJTSAU, Hyderabad. By using 9-point hedonic scale the organoleptic parameters like colour, appearance, flavour, texture, taste, chewiness and overall acceptability were evaluated. The bars were scored from 1 - 9 with 1 being I dislike extremely *i.e.*, very bad and 9 being I like extremely *i.e.*, the product is excellent in that particular attribute (Meilgaard *et al.*, 1999).

Physical properties of developed snack bar

The physical properties analysed were colour (Hunter Lab, 2013), length, breadth (Nouman *et al.*, 2003), spread ratio (Akubor and Ukwuru, 2003), bulk density (Stojceska *et al.*, 2008), tapped density (Narayana and Narasinga, 1982).

Geometric properties of developed snack bar

The geometric properties analysed were volume, density (Yadav and Bhatnagar, 2017), geometric mean dimension (Mohsenin, 1978), aspect ratio (Maduako and Faborode, 1990) and surface area (Jouki and Khazaei, 2012).

Cooking properties of developed snack bar

The cooking properties analysed were gelatinization temperature (Juliano *et al.*, 2009), volume expansion (Sidhu *et al.*,1975), cooking time (Wani *et al.*, 2013), water uptake (Anonymous, 2004) and gruel solid loss (Hamid *et al.*, 2016).

Functional properties of developed snack bar

The functional parameters analysed were water solubility index, water absorption index (Anderson *et al.*, 1969), oil retention capacity (Beugre *et al.*, 2014), foaming capacity

Fig 1: Method for preparation of snack bar.

(Lawhon *et al*., 1972) and hydrophilic-lipophilic index (Njintang *et al.,* 2001).

Nutritional properties of developed snack bar

The nutritional properties analysed were Water activity (aw) (Edson *et al*., 2016), moisture AOAC (2005a), ash and protein (AOAC, 2005b), fat (AOAC, 1997), crude fiber (AOAC, 1990), carbohydrate and energy (AOAC, 1980).

Statistical analysis

All the results will be analysed to test the significance of the results using percentage, means and standard deviation (Snedecor and Cochran, 1983).

RESULTS AND DISCUSSION

The variations in combination of pineapple, beetroot and dates are given in Table 1 from $J35_1$ to $J35_8$. The other ingredients like jaggery, groundnuts, oats and pumpkin seeds remained constant.

The sensory scores of developed bars with 35% jaggery and varying amounts of pineapple, beetroot and dates were shown in Fig 2. The sensory score for the bar with 35% jaggery concentration with 15% pineapple, dates and 5% beetroot, 20% groundnuts, 5% oats and pumpkin seeds was good with regard to appearance, colour, texture, flavour,

Table 1: Snack bar with 35.0% jaggery concentration.

Ingredients	$J35_1$	$J35_2$	$J35_3$	$J35_4$	$J35_5$	$J35_6$	$J35_7$	$J35_8$
Pineapple	15.0	15.0	10.0	20.0	5.0	15.0	5.0	20.0
Beetroot	10.0	5.0	5.0	10.0	20.0	5.0	5.0	5.0
Dates	10.0	15.0	20.0	5.0	10.0	15.0	25.0	10.0
Jaggery	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Groundnuts	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Oats	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Pumpkin seeds	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

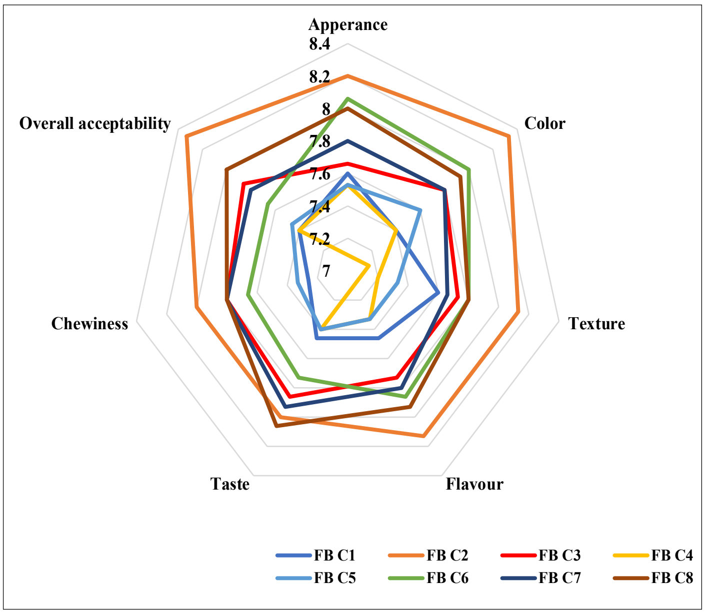

Fig 2: Sensory parameters of 35% concentration jaggery bars.

Note: Values are expressed as mean ± standard deviation of fifteen determinations.

Means within the same column followed by a common letter do not differ significantly at $p \leq 0.05$.

FB C_1: Pineapple (1.5): beetroot (1.0): dates (1.0).

FB C_2: Pineapple (1.5): beetroot (0.5): dates (1.5).

FB C_3: Pineapple (1.0): beetroot (0.5): dates (2.0).

FB C_4: Pineapple (2.0): beetroot (1.0): dates (0.5).

FB C_5: Pineapple (0.5): beetroot (2.0): dates (1.0).

FB C_6: Pineapple (1.0): beetroot (1.0): dates (1.5).

FB C_7: Pineapple (0.5): beetroot (0.5): dates (2.5).

FB C_8: Pineapple (2.0): beetroot (0.5): dates (1.0).

taste, chewiness and overall acceptability was 8.20, 8.33, 8.13, 8.13, 8.00, 8.00, 8.33 respectively.

Next was for the bar with 20% pineapple, 10% dates and 5% beetroot the scores for appearance, colour, texture, flavour, taste, chewiness and overall acceptability were 8.00, 7.93, 7.80, 7.93, 8.06, 7.80 and 8.00 respectively followed by the bar with 10% pineapple, 5% beetroot and 20% dates and parameters like appearance, colour, texture, flavour, taste, chewiness and overall acceptability was 7.66, 7.80, 7.73, 7.73, 7.86, 7.80 and 7.86 respectively. Next was for the bar with 5% pineapple, beetroot and 25% dates with the scores for appearance, colour, texture, flavour, taste, chewiness and overall acceptability was 7.80, 7.80, 7.66, 7.80, 7.93, 7.80 and 7.80 respectively.

Next was for the bar with 10% pineapple and beetroot and 15% dates with scores for the parameters like appearance, colour, texture, flavour, taste, chewiness and overall acceptability was 8.06, 8.00, 7.80, 7.86, 7.73, 7.66 and 7.66 respectively followed by bar with 5% pineapple, 20% beetroot and 10% dates the scores for sensory parameters like appearance, colour, texture, flavour, taste, chewiness and overall acceptability was 7.53, 7.60, 7.33, 7.33, 7.40, 7.33 and 7.46.

The least sensory scores was for the bars with 15% pineapple, 10% beetroot and dates with regard to appearance, colour, texture, flavour, taste, chewiness and overall acceptability was 7.60, 7.40, 7.60, 7.46, 7.26 and 7.40 and for the bar with 20% pineapple, 10% beetroot and 5% dates with parameters like appearance, colour, texture, flavour, taste, chewiness and overall acceptability was 7.53, 7.40, 7.20, 7.33, 7.40, 6.86 and 7.40.

The acceptability of the bar with 35.0% jaggery was high when compared to other jaggery concentrations like 15.0, 20.0 and 30.0% due to increase in jaggery and groundnut content which increased the protein content of the bar along with mouthfeel of the bars.

Physical properties of developed snack bar

The developed fruit bar was cut to pieces of 50.0 g weight each for analysing physical parameters like colour, length, breadth, thickness, spread ratio, bulk density tapped density, pH, TA, TSS and FFA as shown in Table 2.

Colour

The 'L' value was 22.46±0.11 and 52.12±0.02, 'a' value was 7.89±0.03 and 5.63±0.01, 'b' values was 3.44±0.02 and 30.36±0.15, 'E' values was 24.05±0.11 and 60.58±0.08, C* value was 30.88±0.15 and 8.60±0.33 and h* value was 79.48±0.03 and 23.56±0.15 for test bar and control samples respectively. There was statistically significant difference at $p \leq 0.05$. The primary pigments of fruits and vegetables imparted the colour to them. As they were sensitive to light and heat, they undergo oxidation and changing the product colour (Barret *et al.*, 2010). The betanin pigment present in beetroot aided to impart desired red colour to the product (Clydesdale and Francis, 1976). The incorporation of fruits and vegetables increased the darkness of the colour compared to control.

Thickness

The thickness of test bar was 1.04±0.13 cm and the control was 0.94±0.00 cm. There was statistically significant difference at $p \leq 0.05$ between the samples. The increase in the thickness was due to the addition of fruits and vegetables (Rufeng *et al.*, 1995).

Length

The length for test and control bars were 8.58±0.04 and 8.76±0.01cm respectively. There was statistically significant difference at $p \leq 0.05$ between the samples and length of test bar decreased due to incorporation of fruits and vegetables.

Breadth

The breadth for test and control bars were similar with 3.20±0.02 cm. There was statistically no significant difference at $p \leq 0.05$ as were prepared with more or less similar thickness for aesthetic purpose.

Spread ratio

The spread ratio of test bar was 3.09±0.18 and control was 3.40±0.01. There was statistically significant difference at $p \leq 0.05$ and spread ratio decreased due to the addition

Table 2: Physical properties of test sample.

Samples	l (cm)	b (cm)	T (mm)	SR	BD (g/L)	TD (g/ml)	pH	TA (g/L)	TSS (°brix)	FFA (%)
Control	8.76^{b}±	3.20^{a}±	0.94^{a}±	3.40^{b}±	0.86^{a}	0.92^{a}±	5.85^{b}±	0.10^{a}±	8.13^{a}±	3.56^{b}±
	0.01	0.02	0.01	0.01		0.00	0.02	0.01	0.23	0.02
Test bar	8.58^{a}±	3.20^{a}±	1.04^{b}±	3.09^{a}±	0.93^{b}	0.98^{a}±	5.73^{a}±	0.13^{a}±	11.26^{b}±	3.36^{a}±
	0.04	0.02	0.13	0.18		0.00	0.02	0.00	0.11	0.00
Mean	8.62	3.20	0.96	3.24	0.89	0.93	5.79	0.11	9.69	3.46
SE of mean	0.00	0.00	0.02	0.00	0.02	0.01	0.01	0.00	0.01	0.00
CD	0.04	0.00	0.04	0.02	0.02	0.01	0.07	0.00	0.09	0.01
% CV	0.14	0.00	0.58	0.21	0.48	0.43	0.35	0.35	0.25	0.09

Note: Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at $p \leq 0.05$.

Control: Groundnuts (1.0): jaggery (1.0); Test bar: Jaggery (3.5): pineapple (1.5): beetroot (0.5): dates (1.5); l: Length b: Breadth; Thickness; SR: Spread ratio. BD: Bulk density; TD: Tapped density; TA: Titratable acidity; TSS: Total soluble sugars.

of fruits to it. A study revealed that addition of soy flour to biscuits reduced the spread ratio (Hooda and Jood, 2005).

Bulk density

The bulk density was 0.93 and 0.86 g/L for test and control bars respectively. There was statistically no significant difference at $p \leq 0.05$. The bulk density was generally affected by particle size was very important in determining the packaging requirement, raw material handling and has application in wet processing in food industry (Adebowale *et al*., 2012 and Ajanaku *et al*., 2012).

Tapped density

The tapped density of test bar was 0.98±0.00 and control was 0.92±0.00 g/ml. There was statistically no significant difference at $p \leq 0.05$ by and was more or less similar for both samples.

pH

The pH content of test bar was 5.73±0.02 and control was 5.85±0.02 with statistically significant difference at $p \leq 0.05$ for both samples.

Titratable acidity (TA)

The TA of test bar was 0.13±0.00 and control was 0.10±0.01 % with no significant difference statistically at $p \leq 0.05$ for the samples.

Total soluble sugars (TSS)

The TSS content was 11.26±0.11 and 8.13±0.23% for test and control bars respectively with statistically significant difference at $p \leq 0.05$ for the samples. The higher TSS in test bar may be due to the jaggery content along with addition of processed fruits and vegetables.

Free fatty acids (FFA)

The FFA content of test bar was 3.36±0.00 and control was 3.56±0.02% with statistically significant difference at $p \leq 0.05$. The addition roasted groundnuts undergo rancidity due to atmospheric air resulting in FFA in both samples.

Geometric characteristics of developed healthy snack bar

The physical and geometric properties were important in designing of processing machines for agricultural crops to reduce post-harvest losses and enhance productivity (Owolarafe *et al*., 2007). The geometric properties like size and shape were important physical properties that affected final produce and included planting, harvesting, handling, threshing, sorting and drying (Mohsenin, 1978; Nalbandi *et al*., 2010). For the possibility of developing handling and processing equipment some engineering properties like size, true density, bulk density, porosity (Ogunjimi *et al*., 2002). The geometric properties that include volume, density, D_e, AR and S were given in Table 3.

Volume

The volume of test bar was 28.27±0.07 cm^3 and for control was 26.35±0.04 cm^3. There was statistically significant difference at $p \leq 0.05$ and volume increased to certain extent due to the addition of the fruits, vegetable and other ingredients like oats, pumpkin seeds and groundnuts (Simona *et al*., 2014).

Density

The density of test bar was 1.76±0.00 and control was 1.13±0.00 g/cm^3. There was statistically significant difference at $p \leq 0.05$ and addition of the nuts may have increased the protein content which eventually decreased the density (Simona *et al*., 2014).

Geometric mean dimension (D_e)

The D_e of test bar was 9.42±0.01 and control was 8.68±0.01. There was statistically significant difference at $p \leq 0.05$ between the samples.

Aspect ratio (AR)

The AR of test bar was 37.30±0.01 and control was 36.52±0.00 and there was statistically significant difference at $p \leq 0.05$ between the samples.

Surface area (S)

The SA of test bar was 278.88±0.00 and control was 236.57±0.00 mm. There was statistically significant difference at $p \leq 0.05$ between the bars.

Cooking qualities of developed snack bars

The cooking qualities analysed are given in Table 4 below.

Table 3: Geometric properties of snack bar.

Sample	V (cm^3)	D (cm^3)	D_e (mm)	AR	SA (mm^2)
Control	26.35^a±0.04	1.13^b±0.00	8.68^a±0.01	36.52^a±0.00	236.57^a±0.00
Test bar	28.27^b±0.07	1.76^a±0.00	9.42^b±0.01	37.30^b±0.01	278.88^b±0.00
Mean	27.31	1.44	9.05	36.91	257.72
SE of mean	0.46	0.00	0.16	0.17	9.46
CD	0.00	0.00	0.05	0.04	0.00
% CV	2.89	0.07	0.18	0.03	0.00

Note: Values are expressed as mean ± standard deviation of ten determination; Means within the same column followed by a common letter do not significantly differ at $p \leq 0.05$; Control: Groundnuts (1.0): jaggery (1.0); Test bar: Jaggery (3.5): pineapple (1.5): beetroot (0.5): dates (1.5); V: Volume; D: Density; D_e: Geometric mean dimension; AR: Aspect ratio; S: Surface ratio.

Gelatinization temperature (GT)

The GT of test bar was 96.26±0.11! and control was 88.13±0.11!. There was statistically significant difference at p≤0.05 between both samples. The gelatinization of starch present in the grains determined the product quality during processing as it effectively functioned as gelling or thickening agent in various products. The increased GT in test bar may be due to addition of fruits and vegetables that contained starch in cell walls. The use of processed fruits and vegetables in baked and extruded items usually was minimal (Biliaderis *et al.,* 1980).

Volume expansion (VE)

The VE of test bar was 2.53±0.01 and control was 2.96±0.02. There was statistically significant difference at p≤0.05 and volume expansion of test sample was lesser than control due to lower amount of jaggery added to the bars.

Cooking time (CT)

The CT for test bar was 9.85±0.01 min and control was 7.63±0.01 min. There was statistically significant difference at p≤0.05 and cooking time of control was lesser than test sample. The starch content in fruits and vegetables may have lowered the cooking time of test bar.

Water uptake (WU)

The WU of test bar was 4.02±0.01 and control was 4.47±0.00 and there was statistically significant difference at p≤0.05. The water uptake of test bar was lesser than control as processed fruits and vegetables were unable to absorb water due to changes in cell wall structure.

Gruel solid loss (GSL)

The GSL of test sample was 9.62±0.01 and control was 8.96±0.01. There was statistically significant difference at p≤0.05 and GSL of control was lesser than test bar. The addition of pseudo cereal like oats may have increased GSL in test bar than control.

Functional properties of developed healthy snack bar

The functional properties analysed are given in Table 5.

Water activity (a_w)

The water activity was analysed at around 20°C for both the samples. The a_w of test bar was 0.44 and control was 0.37. There was no major difference in values and statistically significant difference at p≤0.05 was observed. Studies showed that a_w was responsible for the keeping quality and process attributes of foods than moisture content during storage of foods (Zamora and Chirife, 2006).

Water absorption index (WAI)

The WAI was related to the availability of hydrophilic groups (-OH) to bind to water molecules for gel formation (Ferreira, 2012). The WAI of the test bar was 1.06±0.00 ml/g and control was 1.87±0.00 ml/g. There was statistically significant difference at p≤0.05.

Table 4: Cooking parameters of snack bar.

Samples	GT (°C)	VE	CT (min)	WU	GSL
Control	88.13^{a}±0.11	2.96^{b}±0.02	7.63^{a}±0.01	4.47^{b}±0.00	8.96^{a}±0.01
Test bar	96.2^{b}±60.11	2.53^{a}±0.01	9.85^{b}±0.01	4.02^{a}±0.01	9.62^{b}±0.01
Mean	92.20	2.74	8.74	4.25	9.29
SE of Mean	1.81	0.10	0.49	0.09	0.14
CD	0.28	0.05	0.02	0.01	0.00
% CV	0.08	0.59	0.09	0.09	0.00

Note: Values are expressed as mean ± standard deviation of three determinations; Means within the same column followed by a common letter do not significantly differ at p≤0.05; Control: Groundnuts (1.0): jaggery (1.0); Test bar: Jaggery (3.5): pineapple (1.5): beetroot (0.5): dates (1.5); GT: Gelatinization temperature. VE: Volume expansion; CT: Cooking time; WU: Water uptake; GSL: Gruel solid loss.

Table 5: Functional properties of the snack bar.

Samples	WAI (ml/g)	WSI (%)	ORC (g)	FC (%)	HLI (%)
Control	1.87^{b}±0.00	0.16^{b}±0.00	1.57^{b}±0.00	11.21^{a}±0.01	1.17^{b}±0.00
Test bar	1.06^{a}±0.00	0.04^{a}±0.00	1.12^{a}±0.01	15.02^{b}±0.01	0.93^{a}±0.01
Mean	1.46	0.10	1.34	13.11	1.05
SE of mean	0.18	0.02	0.00	0.00	0.00
CD	0.00	0.00	0.04	0.02	0.04
% CV	0.00	0.00	0.90	0.04	1.15

Note: Values are expressed as mean ± standard deviation of three determinations; Means within the same column followed by a common letter do not significantly differ at p≤0.05; Control: Groundnuts (1.0): jaggery (1.0); Test bar: Jaggery (3.5): pineapple (1.5): beetroot (0.5): dates (1.5); WAI: Water absorption index; WSI: Water solubility index; ORC: Oil retention capacity; FC: Foaming Capacity; HLI: Hydrophilic-Lipophilic index.

Water solubility index (WSI)

The WSI was related to amount of soluble solids present in a dried sample used to determine the intensity of heat treatment that effected gelatinization, dextrinization and consequently solubilisation of starch with other food components like protein, fat and fibre (Yousf *et al.*, 2017).

Oil retention capacity (ORC)

The ORC of test bar was 1.12±0.01 and control was 1.57±0.00 g. There was statistically significant difference at $p \leq 0.05$ The lower ORC of test bar may be due to less hydrophobic proteins that show superior binding to lipids (Kinsella, 1979). The complex capillary attraction process helped in better flavour retention, consistency traits and an increased mouth-feel of developed product (Khattab and Arntfield, 2009).

Foaming capacity (FC)

The FC of test bar was 15.02±0.01 and control was 11.21±0.01%. There was statistically significant difference at $p \leq .05$. FC helped to maintain properties like texture and structure in baked and frozen food products (Sathe *et al.,* 1982). The lower the solubility of proteins, lower the foaming capacity of the products (Karim and Wai 1999).

Hydrophilic-Lipophilic index (HLI)

The HLI of test bar was 0.93±0.01 and the control was 1.17±0.00. There was statistically significant difference at $p \leq 0.05$. HLI can help to determine the water to oil emulsion formation in food products.

Proximates of developed snack bar

The proximates like moisture, ash, protein, fat and crude fiber analysed with computation of carbohydrates and energy are given in Table 6.

Moisture

The moisture content of test bar was 6.98±0.03% and control was 4.17 ±0.01% with statistically significant difference at $p \leq 0.05$ for the samples. There was an increase of 67.38% in moisture content of test bar than control. The gradual increase in moisture was due to addition of fruits and vegetables to bars because fruits and vegetables contained water content of 80.0% (Ahmed *et al.,* 2005).

Ash

The ash content of test bar was 1.57±0.02% and control was 1.60±0.10% and there was no statistically significant difference at $p \leq 0.05$. There was a decrease of 1.88% in ash content for control than test bar. It may be attributed to addition of fruits and vegetables which contained more organic matter (Othman, 2011).

Protein

The protein content of test bar was 13.47±0.00% and control was 10.32±0.00% with statistically significant difference at $p \leq 0.05$ between them. The protein content of test bar was 30.52% higher than control. The studies have shown that addition of pumpkin seeds and beetroot increased protein and nitrogen content respectively (Omran, 2018).

Fat

The fat content of test bar was 6.36±0.14% and control was 11.61±0.16%. There was statistically significant difference at $p \leq 0.05$ between the samples. The lowered fat content by 45.22% in test bar may be due to the addition of fruits and vegetables which were low energy dense foods compared to groundnuts (Orrego *et al.*, 2014).

Crude fibre

Crude fibre was the residue that remained after vigorous acid and alkali treatment of foods (Mehta and Kaur, 1992). The crude fibre of test bar was 8.40±0.00% and control was 4.70±0.00%. There was statistically significant difference at $p \leq 0.05$ between samples. The crude fibre of test bar was 78.72% higher than control. The crude fibre content was high in fruits and vegetables (Hoosain *et al.*, 2015).

Carbohydrates

The carbohydrate content of test bar was 63.22±0.06 and control was 67.60±0.09% with statistically significant difference at $p \leq 0.05$ between the samples. The carbohydrate content of test sample was 6.48% lower than control due to increased moisture and decreased fat content..

Table 6: Proximate composition of snack bar.

Samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrates (%)	Energy (Kcal/100 g)
Control	4.17^a±0.01	1.60^b±0.10	10.32^a±0.00	11.61^b±0.16	4.70^a±0.00	67.60^b±0.09	416.17^b±0.12
Test bar	6.98^b±0.03	1.57^a±0.02	13.47^b±0.00	6.36^a±0.14	8.40^b±0.00	63.22^a±0.06	357.24^a±0.13
Mean	5.57	1.59	11.89	8.95	6.55	64.56	386.70
SE of mean	1.00	0.02	0.70	1.16	0.82	1.36	13.10
CD	0.07	0.18	0.00	0.38	0.00	0.33	3.09
% CV	0.33	3.39	0.00	1.22	0.00	0.14	0.22

Note: Values are expressed as mean ± standard deviation of three determinations.

Means within the same column followed by a common letter do not significantly differ at $p \leq 0.05$.

Control: Groundnuts (1.0): jaggery (1.0) Test bar: Jaggery (3.5): pineapple (1.5): beetroot (0.5): dates (1.5).

Table 7: Cost of fruit-based snack bar per serving.

Sample	Cost per 100 g in Rs	Cost per serving in Rs
Control	20.00	5.00
Test bar	40.00	10.00

Energy

The energy content of test bar was 357.24±0.13 and control was 416.17±0.12 Kcal/100 g. There was statistically significant difference at $p \leq 0.05$ and energy content increased by 14.17% in control due to its high fat content in it. The high moisture content of fruits and vegetables made them low energy foods thus suggesting usefulness in treatment of obesity, diabetes and other chronic diseases (Muller and Tobin, 1980).

Cost analysis of developed fruit-based snack bar

The price of the developed fruit-based snack bar was estimated including cost of raw materials, processing and preparation. The cost of the bar per serving of 25.0 g ranged around Rs 10/- as shown in Table 7. As the cost of the bars was feasible so commercialization of the product can be taken up.

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Author contributions

S. Rachana Sree carried out the experimental work, data analysis and drafted the manuscript. Jessie Suneetha. W has conceptualized, supervised the study and critically revised the draft. V. Kavitha Kiran has helped with statistically analysis. All authors have approved the final version of the manuscript.

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REFERENCES

Adebowale, A.A., Adegoke, M.T., Sanni, S.A., Adegunwa, M.O., Fetuga, G.O. (2012). Functional properties and biscuit making potentials of sorghum-wheat flour composite. American Journal of Food Technology. 7(6): 372-379.

Ahmed, S.A., Vashney, A.K., Srivasta, P.K. (2005). Quality attributes of fruit bar made from papaya and tomato by incorporating hydrocolloids. International Journal of Food Properties. 8(1): 89-99.

Ajanaku, K.O., Ajanaku, C.O., Edobor-Osoh, A., Nwinyi, O.C. (2012). Nutritive value of sorghum ogi fortified with groundnut seed (*Arachis hypogaea* L.). American Journal of Food Technology. 7: 82-88.

Akubor, P.I. and Ukwuru, M.U. (2003). Functional properties and biscuit making potential of soybean and cassava flour blends. Plant Foods for Human Nutrition. 58(3): 1-12.

Al-Hooti, S.A., Sidhu, J.S., Otaibi, A., Ameeri, H.A., Qabazard, H. (1997). Date bars fortified with almonds, sesame seeds, oat flakes and skim milk powder. Plant foods for Human Nutrition. 5(2): 125-135.

Anderson, R.A., Conway, H.F., Pfeifer, V. F., Griffin, E.L. (1969). Gelatinization of corn grits by roll and extrusion cooking. Cereal Science Today. 14: 4-7.

Anon. (1992). Food Composition Tables for the Near East. Publication. 26: 64-72.

Anonymous. (2004). Laboratory Manual on Rice Grain Quality Procedure. Directorate of Rice Research. Rajendranagar, Hyderabad, India. 1-20.

AOAC. (1980). Official Methods of Analysis. Association of Official Analytical Chemists. Washington, D.C. USA.

AOAC. (1990). Official Method of Analysis for Fibre. Association of Official Analysis Chemists. (14th ed). Washington DC. USA.

AOAC. (1997). Official Methods of Analysis for Fat (crude) or Ether Extract in Flour. Association of Official Analytical Chemists. 16th ed. 3rd Revision. Gaithersburg, Maryland 20877-2417. AOAC 920.85. Chap 32, pp 05.

AOAC. (2000). Method of Analysis, (17th ed). Association of Official Analysis Chemists. Washington DC. USA.

AOAC. (2005). Official Methods of Analysis for Ash in Fflour. Association of Official Analytical Chemists. (18th ed). Arlington VA 2209, USA. AOAC 929.09, chap 32. pp 01.

AOAC. (2005). Official Methods of Analysis for moisture in flour. Association of Official Analytical Chemists. (18th ed). Arlington VA 2209, USA. AOAC 929.03. 32: 02.

AOAC. (2005). Official Methods of Analysis for Protein. Association of Official Analytical Chemists. (18th ed). Arlington VA 2209, USA. AOAC 984.13, chap 04, pp 31.

Barrett, D.M., Beaulieu, J.C., Shewfelt, R. (2010). Color, flavor, texture and nutritional quality of fresh-cut fruits and vegetables: Desirable levels, instrumental and sensory measurement and the effects of processing. Critical Reviews in Food Science and Nutrition. 50: 369-389.

Beugre, G.A.M., Yapo, B.M., Blei, S.K., Gnakri, D. (2014). Effect of fermentation time on the physico-chemical properties of maize flour. International Journal of Research Studies Biosciences. 2: 30-38.

Biliaderis, L.G., Maurice, T.J., Vose, J.R. (1980). Starch gelatinisation phenomena studied by differential scanning calorimetry. Journal of Food Science. 45: 1669-1674.

Chitkara, M., Kohli, R., Sandhu, I.S., Singh, D., Sindhu, R.K. (2017). Development and nutritional, organoleptic, biochemical analysis of polyherbal (stevia, banana, cocoa butter, oats) energy bar. Journal of Advances in Food Science and Technology. 4(20): 62-66.

Clydesdale, F.M. and Francis, F.J. (1976). In: Principles of Food Science Part I. Food Chemistry. Fennema, O.R, Marcel Dekker, New York.

Darmon, N., Darmon, M., Maillot, M., Drewnowski, A. (2005). A nutrient density standard for vegetables and fruits: Nutrient per calorie and nutrients per unit cost. Journal of the American Dietetic Association. 105(12): 1881-1887.

Dibsdall, L.A., Lambert, N., Bobbin, R.F., Frewer, L.J. (2002). Low-income consumers' attitudes and behaviour towards access, availability and motivation to eat fruit and vegetables. Public Health Nutrition. 6(2): 159-168.

Edson, P.D.S., Helosia, H.S., Clarissa, D., Eduardo, V.D.B.V.B. (2016). Physicochemical and sensory characteristics of snack bars added of jeriva flour (*Syagrus romanzoffina*). Food Science and Technology. 36(3): 421-425.

Ferreira, A.E. (2012). Production, characterization and use of jabuticaba bark flour in cookies. Journal of Food and Nutrition. 23(4): 603-607.

Hamid, S., Muzaffar, S., Wani, I.A., Masoodi, F.A., Bhat, M.M. (2016). Physical and cooking characteristics of two cowpea cultivars grown in temperate Indian climate. Journal of the Saudi Society of Agricultural Sciences. 15(2): 127-134.

Hogan, A.S., Chaurin, V., Kennedy, B.T.O., Kelly, P.M. (2012). Influence of dairy proteins on textural changes in high-protein bars. International Dairy Journal. 26(1): 58-65.

Hooda, S. and Jood, S. (2005). Organoleptic and nutritional evaluation of wheat biscuits supplemented with untreated and treated fenugreek flour. Food Chemistry. 90: 427-435.

Hossain, M.D.F., Akhtar, S., Anwar, M. (2015). Nutritional value and medicinal benefits of pineapple. Nutrition and Food Sciences. 4(1): 84-88.

Hunter Lab. (2013). Hunter Association Laboratory-Manual Version-2.1.60: 1014-323.

Juliano, B.O., Perez, C.M., Resurreccion, A.P. (2009). Apparent amylase content and gelatinization temperature types of Philippine rice accessions in IRRI gene bank. The Philippine Agricultural Scientist. 92(1): 106-109.

Karim, A.A. and Wai, C.C. 1999. Foam-mat drying of starfruit (*Averrhoa carambola* L.) puree. stability and air drying characteristics. Food Chemistry. 64 (3): 337-343.

Kathiravan, T., Nadanasabapathi, S., Kumar, R. (2014). Standardization of process condition in batch thermal pasteurization and its effect on antioxidant, pigment and 142 microbial inactivation of ready to drink (RTD) beetroot (*Beta vulgaris* L.) juice. International Food Research Journal. 21: 1305-1312.

Khattab, R.Y. and Arntfield, S.D. (2009). Functional properties of raw and processed canola meal. LWT – Food Science and Technology. 42: 1119-1124.

Kinsella, J.E. (1979). Functional properties of soy protein. Journal of American Oil Chemists Society. 56(3): 242-258.

Lawhon, J.T., Cater, C.M., Maltil, K.F. (1972). A comparative study of the whipping potential of extracts from several oil seed flours. Cereal Science Today. 17: 240-294.

Maduako, J.N. and Faborode, M.O. 1990. Some physical properties of cocoa pods in relation to primary processing. IFE Journal of Technology. 2(1): 1-7.

Mehta, K. and Kaur, A. (1992). Dietary fibre: review. International Journal of Diabetes Dev Ctries. 12: 12-8.

Meilgaard, M., Civille, G.V., Carr, B.T. (1999). Sensory Evaluation Techniques. 3rd Ed. CRC Press, Boca Raton.

Mohsenin, N.N. (1978). In physical properties of plant and animal materials. Gordon and Breach Science Publishers, New York.

Muller, H.G. and Tobin, G. (1980). Nutritional and Food Processing, 5th edition, Croom Helm applied biology series, 302 pages, Croom Helm, London.

Nalbandi, H., Ghassemzadeh, H.R., Seiiedlou. (2010). Seed moisture dependent on physical properties of *Turgenia latifolia:* criteria for sorting. Journal of Agricultural Technology. 6(1): 1-10.

Narayana, K. and Narasinga, Rao, M.S. (1982). Functional properties of raw and heat processed winged bean (*Psophocarpus tetragonolobus*) flour. Journal of Food Science. 47(5): 1534-1538.

Nichols, D.J. and Cheryan, M. (1982). Dairy and vegetable protein blends by co-extraction and co-ultra filtration. Journal of Food Science. 47(2): 486-490.

Njintang, N.Y., Mbofung, C.M.F., Waldron, K.W. (2001). *In vitro* protein digestibility and physicochemical properties of dry red bean (*Phaseolus vulgaris*) Flour: Effect of processing and incorporation of soybean and cowpea. Journal of Agricultural and Food Chemistry. 49(5): 2465-2471.

Nouman, R.S., Hassan, M., Saeeda, R., Tabassum, H., Samina, K. (2003). Sensory and physical evaluation of biscuits supplemented with soy flour. Pakistan Journal of Food Science. 13: 45-48.

Ogunjimi, L.A.O., Aviara, N.A., Aregbesola, O.A. (2002). Some engineering properties of locust bean seed. Journal of Food Engineering. 55: 95-99.

Omran, A.A. (2018). Enhancing the nutritional value of oat bars. American Journal of Food Science and Technology. 6(4): 151-160.

Orrego, C.E., Salgado, N., Botero, C.A. (2014). Developments and trends in fruit bar production and characterization. Critical Reviews in Food Science and Nutrition. 54(1): 84-97.

Othman, O.C. (2011). Physicochemical characteristics and levels of inorganic elements in off-vine ripened pineapple (*Ananas comosus* L.) fruits of Dares Salaam, Tanzania. Journal of Science and Technology. 1(1): 23-30.

Owolarafe, O.K., Olabige, M.T., Faborode, M.O. (2007). Physical and mechanical properties of two varieties of fresh oil palm fruit. Journal of Food Engineering. 78: 1228-1232.

Roy, K., Gullapalli, S., Chaudhuri, U.R., Chakraborty, R. (2004). The use of a natural colorant based on betalain in the manufacture of sweet products in India. International Journal of Food Science and Technology. 39(10): 108-1091.

Rufeng, N., Enqi, L., Chuangji, C., Jiangping, Z. (1995). A study of the production of healthy biscuit made with tartary buckwheat grown in North China. Current Advances in Buckwheat Research. 861-865.

Sathe, A K., Deshphande, S.S., Salunkhe, D.K. (1982). Functional properties of lupin seed (*Lupinus mutabilis*) protein and protein concentrates. Journal of Food Science. 42(2): 491-497.

Sidhu, J.S., Gill, M.S., Bains, G.S. (1975). Milling of paddy in relation to yield and quality of rice of different Indian varieties. Journal of Agricultural and Food Chemistry. 23(6): 1183-1185.

Silva, J.S., Marques, T.R., Simao, A.A., Correa, A.D., Pinheiro, A.C.M., Silva, R.L. (2014). Development and chemical and sensory characterization of pumpkin seed flour-based cereal bars. Food Science and Technology. 34(2): 346-352.

Simona, M., Adriana, P., Sevastiha, M. (2014). Preparation and quality evaluation of gluten-free biscuits. Food Science and Technology. 71(1): 38-44.

Singh, B. and Hathan, B.S. (2014). Chemical composition, functional properties and processing of Beetroot- A review. International Journal of Scientific and Engineering Research. 5(1): 679-684.

Snedecor, G. W. and Cochran, W.G. (1983). Statistical Methods. Oxford and IBH publishing company, New Delhi.

Sree, S.R., Suneetha, W.J., Kumari, B.A., Kiran, V.K. (2020). Standardization and evaluation of jaggery based nutriment bars. Journal of Pharmacognosy and Phytochemistry. 9(2): 687-689.

Stojceska, V., Ainsworth, P., Andrew, P., Esra, I., Senol, I. (2008). Cauliflower byproducts as a new source of dietary fibre, antioxidants and proteins in cereal based ready to eat expanded snacks. Journal of Food Engineering. 87: 554-563.

Varela, S.L., Gross, M.G., Marcos, A. (2002). Functional foods and the immune system: a review. European Journal of Clinical Nutrition. 56(3): S29-S33.

Wani, I.A., Sogi, D.S., Gill, B.S. (2013). Physical and cooking characteristics of blackgram (*Phaseolus mungo* L.) cultivars grown in India. International Journal of Food Science and Technology. 48: 2257-2563.

Yadav, L. and Bhatnagar, V. (2017). Consumer acceptability of developed legume supplemented ready to eat cereal bars. Advances in Life Sciences. 5(12): 5157-5161.

Yousf, N., Nazir, F., Salim, R., Ahsan, H., Sirwal, A. (2017). Water solubility index and water absorption index of extruded products from rice and carrot blend. Journal of Pharmacognosy and Phytochemistry. 6 (6): 2165-2168.

Zamora, M.C. and Cherife, J. (2006). Determination of water activity change due to crystallization in honeys from Argentina. Food Control. 17(9): 59-64.