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Sensory evaluation and cost calculation of plant milk and its product

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Abstract
In the present study, three millets (barnyard millet, foxtail millet and finger millet) were used to extract millet milk and also develop product from them. Millet milk chapati spread was made using the millet milk. The residue of millet left after extraction of milk was made into energy bar. Treatment 3 (T_3) of foxtail millet milk received highest score (7.8±0.6) for overall acceptability among all treatments. Similarly, Treatment 2 (T_2) of barnyard millet milk (7.5±0.7) and Treatment 4 (T_4) of finger millet milk received highest score (7.8±0.4) for overall acceptability among all the treatments. Similar results was obtained for treatments of chapati spread. Among energy bars, foxtail millet residue energy bar received highest score (8.6±0.5) for overall acceptability. Cost of 1 L of foxtail millet milk, barnyard millet milk and finger millet milk was calculated to be 26 Rs, 34 Rs and 16 Rs respectively. Similarly, cost of 1 kg of foxtail millet milk chapati spread, barnyard millet milk chapati spread and finger millet milk chapati spread was calculated to be 1270 Rs, 1280 Rs and 1258 Rs respectively. Cost of 1 kg of foxtail millet residue energy bar, barnyard millet residue bar and finger millet residue energy bar was calculated to be 172 Rs, 211 Rs and 122 Rs respectively.

Keywords: Millet milk, chapati spread, residue

Introduction
Since 2700 BC, millet has been cultivated in African nations as one of the ancient cereals. Together, a number of tiny seeded grains that are members of the Poaceae family are referred to as millet. Millet is a highly significant crop since it has a shorter growing season than other major grains, is resistant to diseases and pests, and is known to withstand drought. Food free of gluten is millet. Coarse grains grown in warm areas that have historically been used for food and fodder include sorghum, pearl millet, finger millet, minor millets (barnyard millet, proso millet, kodo millet, tiny millet, and foxtail millet), maize, and barley. Food security is provided by millets cultivation since they are a sustainable food source that contributes to the fight against hunger in a world where climate change is happening. Millets are a crop that helps farmers retain economic security because they require little initial investment and are very resistant to climatic change. Patients with celiac disease can use millet as a replacement [1]. Growing worries about personal health and environmental issues have led to a global upsurge in the popularity of vegetarian diets [2]. This has facilitated the creation of plant-based milk alternatives. The bulk of plant-based milk substitutes in the past, such as soymilk and ragi milk made from finger millet, were produced on a small scale at home or on a big scale for commercial purposes, for the benefit of the family or the community [3].

Plant-based milk substitutes are produced by soaking or wetting dissolved and broken-down plant parts, like seeds or edible sections, in water extracts; alternatively, the raw material can be ground dry and the flour can be recovered with water; the resulting slurry is then filtered or decanted to remove insoluble plant parts and ground debris [4]. Soymilk was the first plant-based milk alternative that could be bought. Additional plant components, including cereals, pseudocereals, and grains like oats, barley, almond, coconut, rice, millet, corn, sorghum, quinoa, and chia, were included in the process of developing non-dairy milk substitutes [5-7]. Since they don't contain certain elements found in dairy products like cholesterol, saturated fats, antigens, and lactose, as well as being a good source of minerals, non-allergic proteins, essential fatty acids, and other nutrients, plant-based milks are a great substitute for dairy

products [8]. A growing number of economically disadvantaged individuals in developing countries are looking for more affordable options, such as plant-based milk substitutes. Grain and legume alternatives for dairy milk are now acknowledged as plant sources of vitamins, dietary fiber, minerals, and antioxidants [8].

Materials and Methods

The study was conducted in the research laboratories of the Chandra Shekhar Azad University of Agriculture and Technology's faculty of food science and nutrition department. The millets used which were foxtail millet, barnyard millet and finger millet were purchased from the local market of Kanpur, Uttar Pradesh. All the other consumables were obtained from the local market in Kanpur, Uttar Pradesh.

Formulation of Products

Millet Milk

200 g of each millet was soaked for 12 hrs. After soaking extra water was drained. Four treatments was made with different millet to water ratio which were named as treatment 1 (T_1), treatment 2 (T_2), treatment 3 (T_3) and treatment 4 (T_4). The ratio of millet to water were as follows: T_1 (1:2), T_2 (1:3), T_3 (1:4) and T_4 (1:5). The soaked 200 g of millet was divided in 4 equal parts of 50 g each and grinded with water according to the different treatments to be prepared. After grinding filtration was done with the help of muslin cloth. The extracted milk was grinded again for 10 minutes for homogenisation.

Millet Milk Chapati Spread

The different treatments of milk was used to make chapati spread. It was mixed with roasted sesame and poopy seeds along with some sugar, nutmeg powder and agar powder. It was cooked on low flame until it started turning brown and taking texture of thick chapati spread.

Millet Residue Energy Bar

The residues left after the milk extraction was roasted with ghee. It was mixed with roasted peanut powder and sesame seeds. Jaggery syrup was made by cooking jaggery with water. Jaggery used was 41% of total residue left. All ingredients were mixed and cooking was done on medium flame until it was cooked. After that it was given shape of energy bar.

Sensory evaluation

A nine-point hedonic scale was used to create an appropriate scorecard. The chosen characteristics were categorized into modalities, which included general acceptability, taste, flavor, texture, color, and appearance. Ten trained panel members were asked to rate each of the attributes stated on the score card on a scale of one to ten.

Statistical Analysis

ANOVA (analysis of variance) was performed on the data. Each sample's scores were tallied for every sensory feature, including appearance, texture, colour, flavour, taste, after taste, and general acceptability. The panel's assessment of the product's sensory quality was represented by the mean value that was determined for each sample attribute.

Results and Discussion

Millet Milk

Cow milk was taken as control group (T_0) during sensory evaluation of millet milk. Among all the treatments of millet milk, overall acceptability of T_3 of foxtail millet milk, T_2 of barnyard millet milk and T_4 of finger millet milk received highest score of 7.8±0.6, 7.5±0.7 and 7.8±0.4 respectively. The overall acceptability of treatments of millet milk of the three millets showed significant difference (p<0.05), with control (T_0) group. The graphical representation of results of sensory evaluation is given in Figure 1, Figure 2 and Figure 3 and tabular representation is given in Table 1

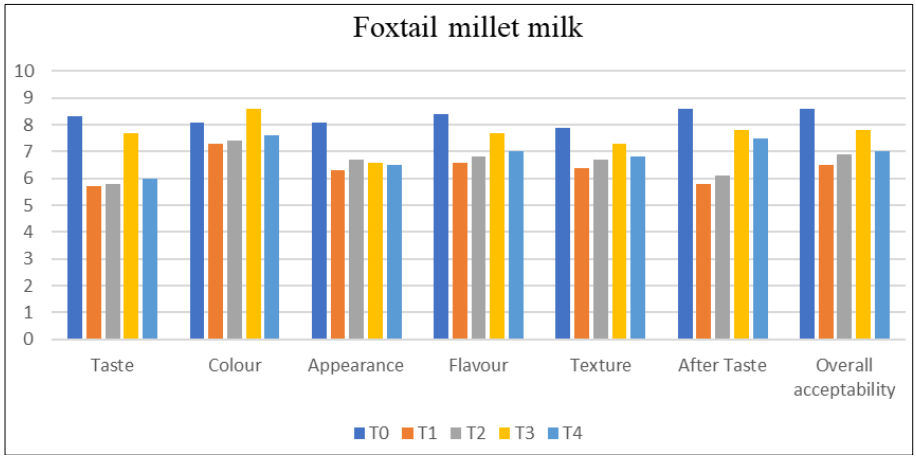

Fig 1: Sensory scores of foxtail millet milk

Control milk (T_0), T_1 (1:2 millet to water ratio), T_2 (1:3 millet to water ratio), T_3 (1:4 millet to water ratios), T_4 (1:5 millet to water ratio)

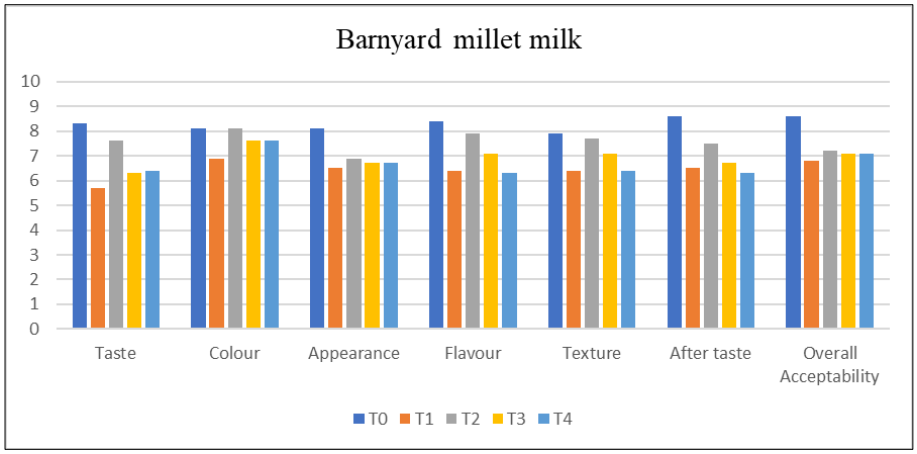

Fig 2: Sensory scores of barnyard millet milk

Control milk (T_0), T_1 (1:2 millet to water ratio), T_2 (1:3 millet to water ratio), T_3 (1:4 millet to water ratios), T_4 (1:5 millet to water ratio)

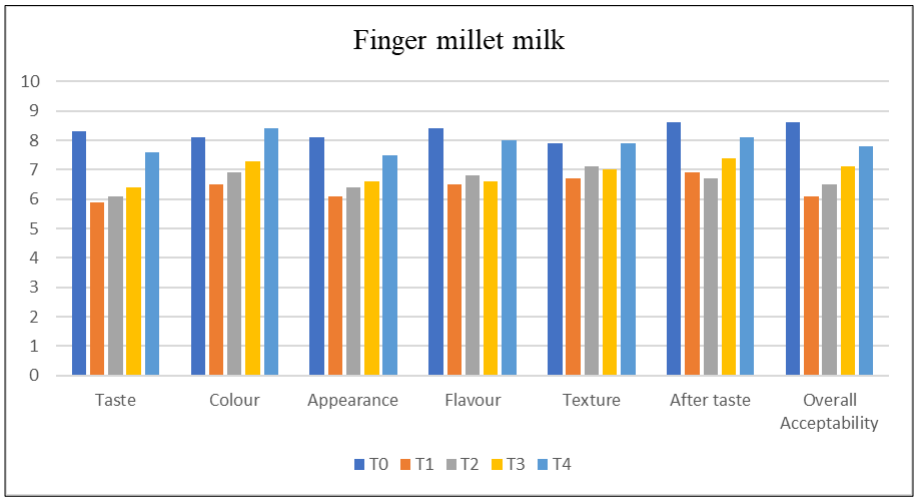

Fig 3: Sensory scores of finger millet milk

Control milk (T_0), T_1 (1:2 millet to water ratio), T_2 (1:3 millet to water ratio), T_3 (1:4 millet to water ratios), T_4 (1:5 millet to water ratio)

Millet Milk Chapati Spread

Among all the treatments of millet milk chapati spread of the three millets used, overall acceptability of T_3 of foxtail millet milk, T_2 of barnyard millet milk and T_4 of finger millet milk received highest score of 8.4±0.6, 8.3±0.6 and 7.6±0.5 respectively. The chapati spread's overall acceptability showed significant difference (p<0.05) from T_1. The graphical representation of the results obtained in sensory evaluation is given in figure 4, figure 5 and figure 6.

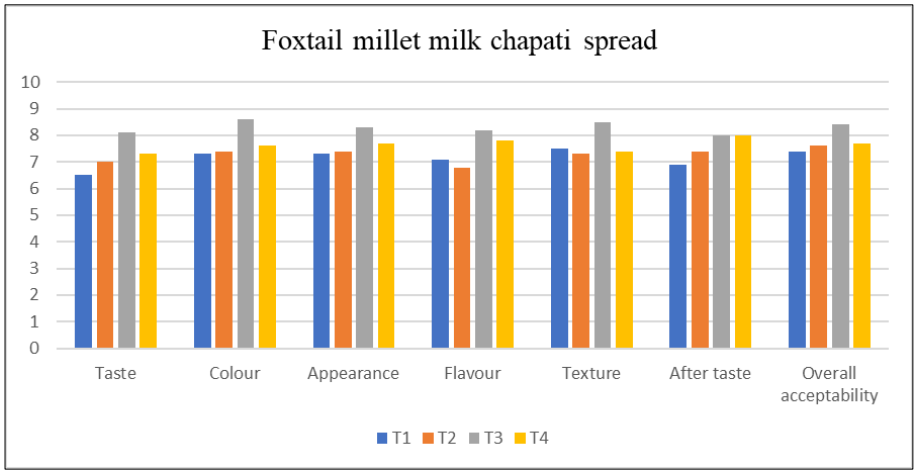

Fig 4: Sensory scores of foxtail millet milk chapati spread

T_1 (T_1 foxtail milk chapati spread), T_2 (T_2 foxtail milk chapati spread), T_3 (T_3 foxtail milk chapati spread), T_4 (T_4 foxtail milk chapati spread)

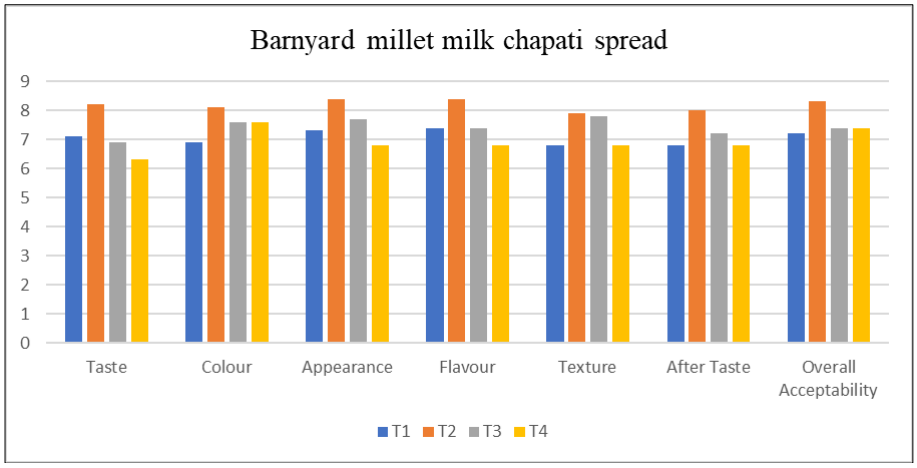

Fig 5: Sensory scores of barnyard millet milk chapati spread

T_1 (T_1 barnyard milk chapati spread), T_2 (T_2 barnyard milk chapati spread), T_3 (T_3 barnyard milk chapati spread), T_4 (T_4 barnyard milk chapati spread)

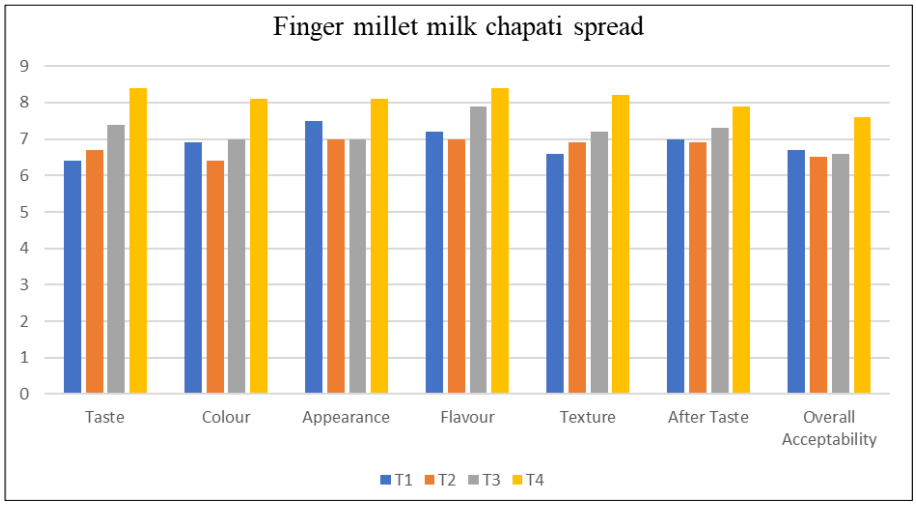

Fig 6: Sensory scores of finger millet milk chapati spread

T_1 (T_1 finger millet milk chapati spread), T_2 (T_2 finger millet milk chapati spread), T_3 (T_3 finger millet milk chapati spread), T_4 (T_4 finger millet milk chapati spread)

Millet Residue Energy Bar

Among the three millet residue energy bars, foxtail millet residue energy bar scored highest in overall acceptability scoring 8.6±0.5 followed by barnyard millet residue energy bar (8.0±0.8) and then finger millet residue energy bar (7.6±0.5). The graphical representation of the sensory scores obtained is represented in figure 7.

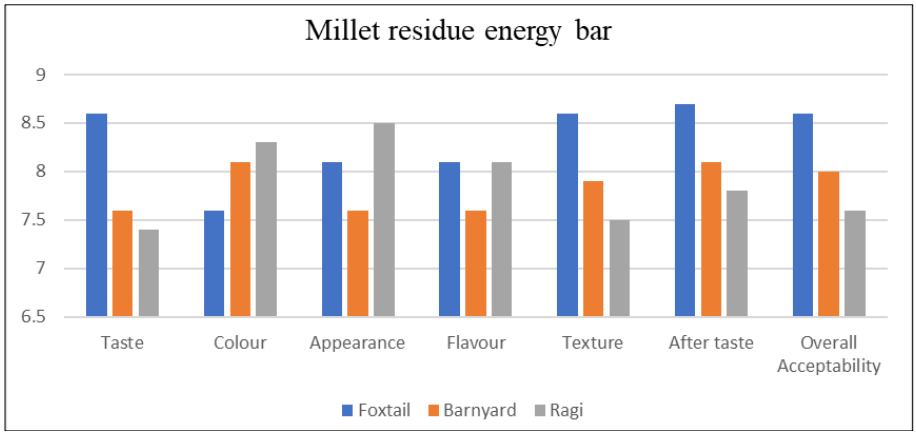

Fig 7: Sensory scores obtained by millet residue energy bar (Foxtail, Barnyard and Finger millet residue energy bar)

The tabular representation of data obtained in sensory evaluation of products is given in Table 1, Table 2 and Table 3.

Table 1: Sensory scores of millet milk

Sensory Parameters		Foxtail millet milk				Barnyard millet milk				Finger millet milk			
	T_0	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Taste	8.3±0.6	5.7±0.6	5.8±0.6	7.7±0.9	6.0±0.6	5.7±0.6	7.6±0.5	6.3±0.6	6.4±0.5	5.9±0.5	6.1±0.7	6.4±0.5	7.6±0.5
Colour	8.1±0.5	7.3±0.4	7.4±0.5	8.6±0.5	7.6±0.6	6.9±0.7	8.1±0.5	7.6±0.5	7.6±0.5	6.5±0.5	6.9±0.5	7.3±0.4	8.4±0.5
Appearance	8.1±0.5	6.3±0.4	6.7±0.4	6.6±0.6	6.5±0.5	6.5±0.5	6.9±0.7	6.7±0.6	6.7±0.6	6.1±0.7	6.4±0.5	6.6±0.5	7.5±0.5
Flavour	8.4±0.5	6.6±0.5	6.8±0.7	7.7±0.4	7.0±0.6	6.4±0.5	7.9±0.7	7.1±0.7	6.3±0.4	6.5±0.5	6.8±0.6	6.6±0.6	8.0±0.8
Texture	7.9±0.5	6.4±0.5	6.7±0.6	7.3±0.6	6.8±0.6	6.6±0.6	7.7±0.6	7.1±0.5	6.4±0.5	6.7±0.4	7.1±0.5	7.0±0.8	7.7±0.4
After Taste	8.6±0.5	5.8±0.7	6.1±0.5	7.8±0.4	7.5±0.5	6.5±0.5	7.5±0.5	6.7±0.8	6.3±0.4	6.9±0.5	6.7±0.4	7.4±0.5	8.1±0.8
Overall Acceptability	8.6±0.5	6.5±0.5	6.9±0.7	7.8±0.6	7.0±0.8	6.8±0.7	7.5±0.7	7.1±0.7	7.0±0.8	6.1±0.7	6.5±0.5	7.1±0.7	7.8±0.4

Note: Values are expressed as mean±SD of three determinations. Control cow milk (T_0), T_1 (millet to water ratio 1:2), T_2 (1:3 millet to water ratio), T_3 (1:4 millet to water ratio), T_4 (millet to water ratio 1:5).

Table 2: Sensory scores of millet milk chapati spread

Sensory Parameters	Foxtail millet milk chapati spread				Barnyard millet milk chapati spread				Finger millet milk chapati spread			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Taste	6.5±0.7	7.0±0.6	8.1±0.8	7.3±0.4	7.1±0.5	8.2±0.7	6.9±0.5	6.3±0.4	6.4±0.5	6.7±0.6	7.4±0.5	8.4±0.6
Colour	7.4±0.5	7.6±0.5	8.0±0.9	7.4±0.5	7.4±0.5	8.4±0.6	7.6±0.6	6.6±0.6	6.9±0.7	6.4±0.5	7.0±0.6	8.1±0.9
Appearance	7.3±0.6	7.4±0.4	8.3±0.4	7.7±0.6	7.3±0.6	8.4±0.6	7.7±0.8	6.8±0.6	7.5±0.5	6.8±0.9	7.0±0.8	8.1±0.9
Flavour	7.1±0.5	6.8±0.7	8.2±0.6	7.8±0.6	7.2±0.4	8.4±0.5	7.4±0.5	6.8±0.7	7.2±0.6	7.0±0.4	7.9±0.7	8.4±0.5
Texture	7.5±0.5	7.3±0.6	8.5±0.5	7.4±0.5	6.6±0.8	7.9±0.8	7.8±0.6	6.8±0.6	6.6±0.5	6.9±0.7	7.2±0.4	8.2±0.7
After Taste	6.9±0.5	7.4±0.5	8.6±0.5	7.7±0.4	6.8±0.6	8.0±0.8	7.2±0.6	6.6±0.6	7.0±0.4	6.9±0.5	7.3±0.6	7.9±0.7
Overall Acceptability	7.4±0.5	7.6±0.5	8.4±0.6	7.7±0.4	7.2±0.6	8.3±0.6	7.7±0.8	7.4±0.5	6.7±0.6	6.5±0.7	6.8±0.9	7.6±0.5

Note: Values are expressed as mean±SD of three determinations. T_1 (millet to water ratio 1:2), T_2 (1:3 millet to water ratio), T_3 (1:4 millet to water ratio), T_4 (millet to water ratio 1:5).

Table 3: Sensory scores of millet residue energy bar

Sensory Parameters	Foxtail millet bar	Barnyard millet bar	Finger millet bar
Taste	8.6±0.5	7.6±0.4	7.4±0.5
Colour	7.6±0.5	8.1±0.7	8.3±0.8
Appearance	8.1±0.7	7.6±0.5	8.5±0.9
Flavour	8.1±0.5	7.6±0.5	8.1±0.5
Texture	8.6±0.5	7.9±0.5	7.5±0.5
After taste	8.7±0.4	8.1±0.5	7.8±0.4
Overall acceptability	8.6±0.5	8.0±0.8	7.6±0.5

Note: Values are expressed as mean±SD of three determination

Calculation of cost of products

Millet Milk

Grinding 200 g of millet with 1000 ml of water gives 1 L of millet milk.The cost of producing millet milk was calculated for 1 litre. The estimated cost of millet milk of the three millets was calculated according to the cost of millet and amount of millet required (200 g) for producing 1 L millet milk. So the estimated cost came as: 26 Rs (Foxtail millet), 34 Rs (Barnyard millet), 16 Rs (Finger millet).

Millet Milk Chapati Spread

For preparing 1000 g (1 kg) spread 1200 ml milk, 250 g sesame, 250 g poppy seeds, 200 gram sugar, 12 gram nutmeg powder and 100 g agar powder is required. The estimated cost calculated was: 1270 Rs (Foxtail millet milk chapati spread), 1280 Rs (Barnyard millet milk chapati spread), 1258 Rs (finger millet milk chapati spread).

Millet Residue Energy Bar

For preparing 1 kg millet residue energy bar, 1 kg of millet is required from which after milk extraction around 800 g residue will be left. Other ingredients required are 120 g jaggery, 55g roasted peanut powder, 5g ghee and 20 g sesame. The estimated cost calculated was: 172 Rs (foxtail millet residue bar), 211 Rs (barnyard millet residue bar) and 122 Rs (Finger millet residue bar).

Conclusion

The millet milk is a very good option for those who cannot consume dairy milk and its products because of lactose intolerance. The developed millet milk and its products was found to be acceptable by people. The particular treatments of the products receiving highest score for overall acceptability can be consumed by people as a substitute for commercially available similar products having ingredients of dairy origin. T_2 of barnyard millet milk, T_3 of foxtail millet milk and T_4 of finger millet milk scored highest in overall acceptability. The chapati spread made with these treatment of milks also scored highest in overall acceptability. Foxtail millet residue energy bar was most acceptable among the other two energy bars. With some further research on these products, they can be made more acceptable by consumers.

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