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Development of Milk Based Malted Finger Millet (Ragi) Health Drink

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Abstract

In India, finger millet (Eleusine coracana) is also referred to as ragi. Finger millet's digestibility, sensory appeal, and nutritional value are all enhanced by malting, which also significantly reduces the anti-nutrients. A powerful medium for the creation of ragi-based value-added goods is milk. This study's goals were to create a milk-based malted ragihealth drink and investigate how malting affects the drink's composition. For the creation of a milk-based malted ragi health drink, the amount of malted ragi flour (4%, 5%, and 6%) added to milk was optimized. 5% malted ragi flour in milk was determined to be the ideal amount to create health drinks based on the findings of the sensory test. When compared to the control (a health drink made with unmaltedragi flour), malting was shown to have a substantial ($P<0.05$) favorable impact on levels of protein, ash, crude fiber, and acidity. Additionally, compared to the control, the health drink's calcium, phosphorus, and vitamin C content rose as a result of malting.

Keywords: Eleusine coracana, Finger millet, malting, Health Drink, Ragi.

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Introduction

Dairy products and milk are nutrient-dense foods that provide substantial amounts of protein, micronutrients, and energy. Dairy products provide plant-based diets more variety. The body's need for vitamins and minerals are mostly met by milk-based value-added products. One of the best sources of necessary amino acids is milk proteins. Food researchers have always chosen milk as an innovative solution to satisfy the constantly shifting tastes of consumers. Many useful substances that are good for human health are produced during the production of milk and milk products, however the majority of these foods are high in fat and low in dietary fiber, which increases the risk of heart disease, colon cancer, obesity, and diabetes mellitus. So, the incorporation of dietary fibers from different sources would enhance the desirability of milk products.

A broad category of small-grained crops known as millets are cultivated for both human use and animal grazing (Goudar et al., 2023).They made up a significant portion of Asian and African cuisines and were among the earliest crops to be cultivated (Amadou et al., 2011). However, millets have been ignored as a result of the green revolution's huge production of key cereal crops. However, millets remain an important component of the diet in underdeveloped nations because to their high nutritional value and resistance to severe weather conditions, such as drought, low rainfall, and poor soil (Gupta et al., 2017). China (9%), Niger (11%), and India (41%) are the top producers of millets (USDA, 2024).

The year 2023 was declared as the “International Year of Millets” by the United Nations to increase awareness about the importance of millets for a healthy and sustainable diet. There are two types of millets: minor (barnyard, finger, kodo, little) and major (pearl, foxtail, proso). Finger millet (ragi) is a commonly farmed millet type in India and Africa (Goudar et al., 2023). Ragi is somewhat more nutritious than other cereals because it is high in minerals like potassium, calcium, and magnesium as well as essential amino acids like tryptophan, lysine, and methionine (Jagati et al., 2021). Additionally, it has high concentrations of polyphenols, including as ferulic, benzoic, gallic, and vanilic acids (AOAC, 2007).

Ragi's high dietary fiber content may help control lifestyle conditions including diabetes and cardiovascular diseases (CVDs) (Jagati et al., 2021). Ragi has historically been employed in a wide range of culinary recipes, either alone or in combination with other cereal grains. The primary problem, though, is that its application is mostly limited to the areas where it is grown. Therefore, it is necessary to create new, inventive, and economically feasible products employing ragi in order to fully leverage its nutritional and physiological advantages.

Ragi's digestibility, sensory appeal, and nutritional value are all enhanced by malting, which also has a noticeable impact on reducing antinutrients. Malting has several advantages, including the elaboration of vitamin C, an increase in phosphorus availability, and the synthesis of lysine and tryptophan (Desai et al., 2010). Weaning meals, quick mixes, drinks, and medicinal goods are all made with malted and fermented ragiflour (Rao and Muralikrishna, 2001). For all age groups, including growing newborns, pregnant women, and the elderly, ragi-based health drinks are an excellent low-calorie option. Therefore, the purpose of this study was to create a milk-based health drink by adding malted ragi and to evaluate how malting affected the organoleptic, physicochemical, and nutritional characteristics of the milk-based ragi health drink.

Materials and Methods

The present study was carried out in the Department Food Science and Technology, BBAU, Satellite Centre, Tikarmafi, Amethi, Uttar Pradesh, India. The research was conducted in several stages. First, homogenized toned milk (200 ml) was mixed with unmalted ragi flour (URF) (5%), sugar (6%), and taste (a sprinkle of cardamom powder) to create the control (milk-based unmalted ragi health drink, MBURHD). In order to create malted ragi flour (MRF), unmalted ragi grains were germinated, malted, and ground. The third phase was creating a milk-based malted ragi health drink (MBMRHD) by adding sugar and flavor (cardamom) and varying the amount of MRF in homogenized toned milk. Lastly, tests were carried out to evaluate how malting affected the organoleptic, physicochemical, and nutritional characteristics of the milk-based ragi health drink. The experimental product had nine duplicates, whereas the control had three.

Raw Materials

A sufficient amount of homogenized toned milk (Amul Taaza) and brown ragi (Indaf-15 cultivar) with the following composition per 100 grams: calories (58.20 kcal), moisture (88.50 g), carbohydrate (4.80 g), protein (3.00 g), fat (3.00 g), ash (0.70 g), and crude fiber (0.00 g). The local market provided the sugar and flavor (cardamom). The investigation employed analytical-grade chemicals.

Preparation of Control Health Drink (MBUHD)

Ragi seeds were cleaned and washed. Seeds were soaked in water for 12-14 h, rinsed, driedin sun and roasted onlow heat and then ground to get fine URF. To prevent lump formation, 10 g (5%) of URF was added to 200 ml of homogenized toned milk that had been heated in a pan while being constantly stirred. The temperature was brought to a boil. Once it reached a boil, it was cooked over a low burner until it took on the consistency of porridge. After heating, 12 grams of sugar (6%) were added, and the somewhat cooled result was flavored with a pinch of cardamom powder. For a sensory assessment, the product was brought to the judging panel at a lukewarm temperature. The product was packaged in polystyrene cups and kept in a refrigerator after cooling.

Preparation of Experimental Health Drink (MBMRHD)

Three different amounts of MRF (MBMRHD1, 4%; MBMRHD2, 5%; and MBMRHD3, 6%) were added to each pan while being continuously stirred to prevent lump formation after homogenized toned milk (200 ml) was heated in three distinct pans. Each pan's contents were brought to a boil. The remaining steps were the same as those used to prepare MBURHD.

Selection of Level of Ragi for Experimental Health Drink (MBMHD)

For the purpose of choosing an experimental health drink, sensory evaluation was done in terms of color and appearance, flavor, consistency, and general acceptance. A control group (MBURHD) containing URF was tested alongside malted ragi health drinks with varying MRF levels (MBMRHD1, MBMRHD2, and MBMRHD3). Samples were evaluated using a nine-point hedonic scale. The final trial product, a milk-based ragi health drink with 5% MRF (MBMRHD2), was chosen for additional research based on a panel of semi-trained judges' sensory judgment.

Nutritional Composition of URF and MRF

Proximate analyses of moisture, protein, fat, crude fiber, and ash levels were performed on URF and MRF. The difference was used to determine the total amount of carbohydrates. All of the aforementioned determinations were made using the standard techniques provided by AOAC (2007).

Proximate Composition of Milk Based Ragi Health Drink (MBRHD)

Proximate, nutritional, and physico-chemical characteristics were examined for both MBURHD and MBMRHD. The AOAC's standard procedures were used to calculate the approximate composition, moisture, and total solids contents (2007). The Kjel-plus digestion equipment and semiautomatic distillation system (Pelican Equipments, Chennai) were used to estimate protein using the Kjeldahl technique. Using a Mojonnier tube and the Roese-Gottlieb technique, fat was extracted in accordance with AOAC (2007) guidelines. Ash content was calculated using a muffle furnace and the gravimetric technique as outlined by AOAC (2007).

Physicochemical Analysis of MBRHD
The titratable acidity of samples was determined by the method described by AOAC (2007).

MBRHD's Nutritional Composition
The difference between the other components—fat, protein, ash, and moisture content—was used to compute total carbs. The total energy was determined by taking into account that 1 g of fat provides 9.3 calories, whilst 1 g of protein and carbs provide 4.1 calories. The samples' crude fiber content was evaluated using the AOAC's non-enzymatic technique (2007). The SOCSPLUS extraction device was used to defat the samples.

MBRHD's Mineral and Vitamin C Content
The studies of Desai et al., (2010) served as references for the calcium, phosphorus, iron, and vitamin C contents of URF and MRF. Gopalan et al., (2009) provided information on the mineral composition of milk and sugar in terms of calcium, phosphorus, and iron, while Cremin and Power (1982) provided information on the amount of vitamin C in milk. Mineral and vitamin C levels were computed for health drink samples based on the aforementioned data.

Statistical Analysis
To determine if there was a significant difference in the mean values, the data was statistically analyzed using the Duncan Multiple Range Test using SPSS software (Steel et al., 1997).

Table 1: Proximate composition of ragi grain flour.

Parameters (%)	Ragi flour	
	Unmalted	Malted
Moisture	11.68±0.01	12.79±0.17
Carbohydrate	77.82±0.02	75.85±0.02
Protein	7.29±0.03	7.53±0.05
Fat	1.08±0.02	1.14±0.04
Crude fiber	3.43±0.07	3.92±0.03
Ash	1.34±0.01	1.85±0.02

Results are mean ±SD of three determinations.

Results and Discussion

Proximate Composition of Ragi Grain Flours (URF and MRF)
Table 2 and Fig. 1 show the approximate composition of ragi grain flours. Protein ash, fat, and crude fiber concentrations increased after malting, according to a compositional study of malted and unmalted ragi flour. But after malting, the amount of carbohydrates dropped. The moisture content didn't change much. The current study's findings closely align with those of WHO (1998), which suggested that the rise in protein may be ascribed to a net synthesis of enzyme protein by germinating seeds. Additionally, the results closely match the typical composition of malted and unmalted ragi flour as reported by Desai et al. (2010).

Table 2: Sensory scores of milk based ragi health drink prepared using different levels of malted ragi flour.

Sensory attributes	Milk based ragi porridge			
	Unmalted Ragi Flour	Malted Ragi flour		
	MBURHD	MBMRHD1	MBMRHD2	MBMRHD3
Colour and appearance	7.11c±0.12	7.38b±0.14	7.89a±0.08	7.61ab±0.12
Texture	6.78c±0.13	7.18b±0.14	7.86a±0.08	7.44ab±0.12
Taste	7.10c±0.12	7.36ab±0.08	8.75 a±0.12	7.65b±0.12
Flavour	7.50b±0.11	7.55b±0.12	8.67b±0.12	7.89a±0.10
Consistency	7.45ab±0.12	7.32b±0.15	7.66a±0.11	7.49ab±0.12
Overall acceptability	7.72b±0.09	7.27b±0.14	8.94a±0.05	7.50b±0.11

Mean±SE; n=18; Means bearing different superscripts in a row differ significantly ($P \leq 0.05$). MBURHD=Milk based ragi heath drink containing 5% URF; MBMRHD1=Milk based malted ragi heath drink containing 4% MRF; MBMRHD2=Milk based malted ragi heath drink containing 5% MRF; MBMRHD3=Milk based malted ragi heath drink containing 6% MRF

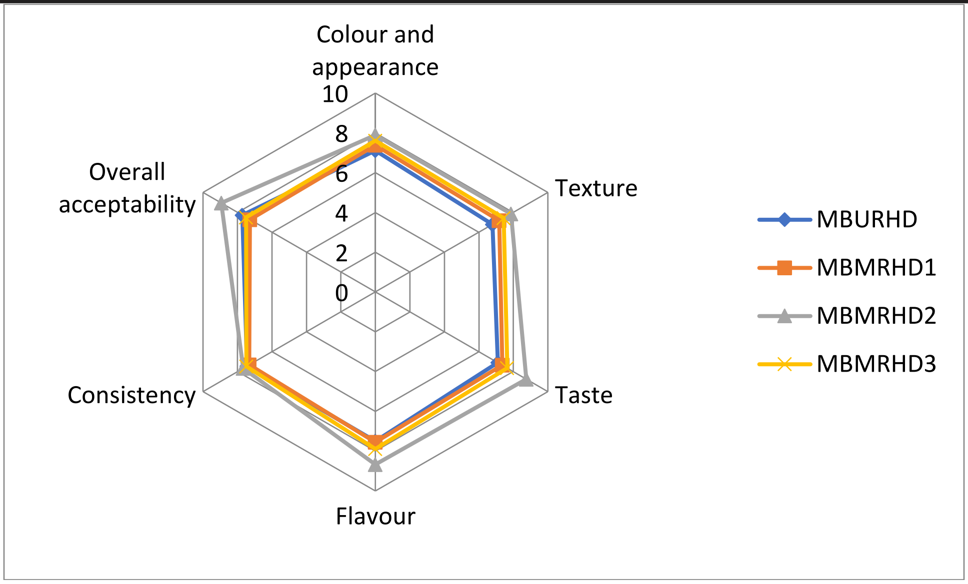

Fig. 1: Sensory evaluation of MBURHD, MBMRHD1, MBMRHD2 and MBMRHD3 sample.

Sensory Evaluation for Ragi Level Selection for Experimental Health Drink

Table 3 shows the sensory scores of a milk-based ragi health drink. The judges judged MBMRHD2 considerably ($P \leq 0.05$) higher than MBMRHD1 and non-significantly higher than MBURHD and MBMRHD3 in terms of color and look. Judges gave MBMRHD2 a far higher flavor preference than MBURHD, MBMRHD1, and MBMRHD3. The judges assessed MBMRHD2's consistency to be substantially greater than MBMRHD1 and non-significantly higher than MBURHD and MBMRHD3. The MBMRHD2 sample had a much better overall acceptability score than the MBURHD, MBMRHD1, and MBMRHD3 samples.

The results clearly showed that, among the ratios examined, MBMRHD made by combining 5% MRF with milk was the most organoleptically acceptable to the panelists. Consequently, MBMRHD with 5% MRF was chosen for more research. The findings are consistent with those of Malleshi and Desikachar (1986) and Pawar and Dhanvijay (2007), who found that finger millet's sensory and nutritional properties are enhanced by malting.

Table 3-Proximate composition of milk based ragi health drink

Parameters (%)	Proximate composition of		
	MBMRHD1	MBMRHD2	MBMRHD3
Moisture	$73.68^{a}\pm0.11$	$73.70^{a}\pm0.09$	$73.67^{b}\pm0.11$
Total solids	$26.32^{a}\pm0.09$	$26.30^{ab}\pm0.11$	$25.80^{c}\pm0.12$
Protein	$3.35^{b}\pm0.00$	$3.45^{a}\pm0.00$	$3.22^{c}\pm0.06$
Fat	$2.89^{c}\pm0.02$	$3.05^{a}\pm0.02$	$3.0^{b}\pm0.05$
Ash	$0.88^{c}\pm0.00$	$0.99^{a}\pm0.00$	$0.91^{b}\pm0.00$
Acidity	$0.31^{c}\pm0.00$	$0.41^{a}\pm0.00$	0.36b±0.00
Total carbohydrates (%)	19.00a±0.06	18.81b±0.05	18.23c±0.02
Crude fiber (%)	0.20c±0.00	0.32a±0.00	0.29b±0.00
Energy (cal/100g)	115.00c±0.07	129.67a±0.16	121.32b±0.13
Calcium	128.69	142.21	143.11
Phosphorus	101.28	106.34	103.28
Iron	0.79	0.89	0.81
Vitamin C	2.01	2.30	2.12

Mean+SE, n=9, Means with different superscripts within a row differ significantly ($p \leq 0.05$). MBURHD=Milk based ragi health drink containing 5% URF; MBMRHD=Milk based malted ragi health drink containing 5% MRF. Minerals and vitamin C values are based upon calculations

Proximate Composition of Milk Based Ragi Health Drink

There was a non-significant ($P>0.05$) difference in the moisture and total solids contents of MBURHD and MBMRHD2, according to the proximate composition data (Table 3). There was absolutely no change in the fat content of MBURHD and MBMRHD2. However, compared to MBURHD, MBMRHD2 had much increased protein, ash, and acidity percentages. The study's protein content results closely align with those of Hassan et al. (2006), who suggested that the increase in protein content of pearl millet cultivars' germinated grains may be caused by a quantitative decrease in antinutritional elements like tannin, phytic acid, and polyphenols, which are known to interact with protein to form complexes.

The fat content results are consistent with those of Desai et al. (2010), who found no discernible variations in the fat content of malted (1.14%) and unmalted (1.08%) ragi flours. It could be the cause of the MBURHD and MBMRHD2 samples' same fat content values. The ash content results were very consistent with those of Subastri et al. (2015), who used both germinated and nongerminated ragi flours to make koozh, a water-based finger millet porridge. They noticed that the mineral contents increased when finger millet germinated. The findings on acidity levels are consistent with those of Inyang and Zakari (2008), who said that acids were generated during pearl millet germination, which aided in product preservation.

Nutritional Composition of Milk Based Ragi Health Drink

The findings showed that, when compared to MBURHD, MBMRHD2 had a significantly higher crude fiber content and a considerably ($P \leq 0.05$) lower total carbohydrate and calorie contents (Table 3). This shown that malting decreased the amount of carbohydrates in milk-based ragi porridge. According to Lasekan (1996), the drop in carbohydrate levels may have been caused by an increase in alpha-amylase activity. During the early phases of germination, the developing seedlings use the simpler, more absorbable sugars that the alpha-amylase breaks down from complex carbohydrates.

The crude fiber levels in MRF (3.9%) and UMRF (3.6%) may be the cause of the notable increase in crude fiber content in MBMRHD2 compared to MBURHD. According to Inyang and Zakari (2008), germinated fura has a substantially greater crude fiber content (2.38%) than conventional fura (2.33%). The MBMRHD2 sample's considerably lower total carbohydrate contents in comparison to the MBURHD sample may be the cause of the notable drop in energy levels.

Minerals and Vitamin C Composition

Table 3 shows the results for vitamin C and minerals. In contrast to MBURP, MBMRHD2 was found to have reduced iron content but greater amounts of calcium, phosphorus, and vitamin C. According to Sangita and Sarita (2000), the iron content of malted finger millet flours dropped while the calcium and phosphorus content rose. According to Taur et al. (1984), the enzymatic hydrolysis of starch by amylases and diastases, which broke down starch and created glucose, was responsible for the rise in vitamin C concentration during malting. This elevated glucose level served as the precursor of vitamin C.

The results of this investigation showed that a milk-based ragihealth drink made with 5% MRF had better sensory acceptance in terms of color and appearance, flavor, consistency, and general acceptability. The health drink sample's levels of protein, ash, crude fiber, and titratable acidity were found to rise after ragi was malted. The milk-based malted ragihealth drink had greater levels of calcium, phosphorus, and vitamin C than the unmalted ragihealth drink. Therefore, the study suggests that creating health drinks with malted ragi and milk in the best possible combination could be a milk-driven value-added product.

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