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Sensory Analysis of Fermented and Unfermented Millet-Based Porridges

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ABSTRACT

Millets have currently exploited as a regular nutritious food as well as in therapeutic diets. Diarrhoeal diseases in children requires immediate remedy due to the problem of dehydration which sets in un-noticed. Fermented and unfermented millet-based replacement fluids are a healthy option to treat and get over the problem of diarrhea. This phase of the study was on the sensory evaluation of the developed Diarrhoeal replacement fluids based on Finger millet (Ragi) (*Eleucine coracana*) and Pearl millet (Pennisetum typhoides). The results indicate that there are significant differences in the perceived flavor, odour, and overall acceptability of fermented porridge made from pearl millet and finger millet. Finger millet appears to be preferred in terms of these sensory attributes. However, there were no significant differences in appearance and mouthfeel between the two types of millet porridge. Fermented porridge is preferred in terms of these sensory attributes.

Introduction

Millet is a generic term applied to a heterogenous group of small seeded cereal crops which are known for their small coarse grains (Weber and Fuller, 2006). Finger millet has some of the inherent qualities, which makes it superior compare to other cereals and also qualify for malting and preparation of malted foods. It is resistant to fungal infection; elaboration of alpha and beta amylase takes place during germination and during roasting/ kilning, a desirable aroma is developed, which makes it an ideal grain for malt foods. Keeping in view the above mentioned facts, this review has been presented here to attract the attention of future workers for development of novel technology to prepare ready to serve fermented ragi porridge for commercial exploitation to the entrepreneurs and industry.

Finger millet flour is used for different food preparations, namely flat unfermented breads (Roti), porridges (thick and thin), Puttu, Dosai, Idly, and several other sweetened snacks in Asia (Shobana et al. 2013; Kumari et al. 2019b). Finger millet porridges (FMP) are popular weaning food for infants and a nutritious food for pregnant mothers and elderly (Shobana et al. 2013). FMP is a nutritionally balanced meal and preparation of porridge is convenient compared to other dishes which use finger millets flour (Shobana et al. 2013).

Processing ragi using traditional as well as modern techniques for the development of value added and convenient food products would be the possible solution for its promotion and enhancement of consumption, nutritional status and thereby increasing profitability and better livelihood to the tribal community. There are various benefits of malting of ragi such as vitamin-C is elaborated, phosphorus availability is increased and lysine and tryptophan are synthesized (Desai et al., 2010).

Ragi porridge serves as an ideal low-calorie diet for all age groups especially growing infants and pregnant women. Ragi has some of the inherent qualities, which makes it superior compared to other cereals and also qualify for malting and preparation of malted foods. It is resistant to fungal infection; elaboration of alpha and beta amylase takes place during germination and during roasting/ kilning, a desirable aroma is developed, which makes it an ideal grain for malt foods (Jain, et al., 2017).

Materials and Method

Method of Porridge Preparation

Traditional recipes were used by the researcher for standardizing both types of porridge. High-quality finger and pearl millet were obtained from a local grocery store. The millet underwent a thorough cleaning, washing, and drying process to eliminate any impurities or dust particles. Subsequently, the dried millet was finely ground into flour. A quantity of one hundred grams of flour was used for each porridge i.e finger and pearl millet porridge. List of ingredients used for finger millet and pearl millet porridge is showninthefollowingTable1.

Table 1. List of Ingredients for Porridge Preparation

Ingredients	Quantity (g)
Millet flour (Finger/ Pearl)	100
Broken rice	20
Salt	2
Water	4 to 5 cups

Unfermented Porridge

To prepare both types of unfermented millet porridge, the flour was mixed with one cup of water to form slurry. To this mixture, twenty grams of washed and soaked broken rice were added. The combined ingredients were then cooked with adequate water until it reached porridge consistency. Salt was added for taste.

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Fermented Porridge

This porridge underwent fermentation at two different stages, before and after cooking. To prepare fermented millet porridge, 100 grams of flour was mixed with water in a 1:1 ratio and allowed to ferment for 15 hours (First fermentation). This fermented slurry was then cooked with 20 grams of cleaned and washed broken rice, along with adequate water, until it reached a porridge-like consistency. The cooked porridge then underwent an additional 15 hours of fermentation (second fermentation). Salt was added for taste. The fermented porridge was further thinned using boiled, cooled water. Traditionally, the porridge is served cold.

Sensory Analyses

Among the total of 315 participants, a subset of 30 mothers underwent sensory profiling for the millet porridges. The criteria for inclusion were a readiness to participate, proficiency in reading and writing Tamil or English, and absence of any significant illnesses during the study period. The participants were explained about sensory profiling and procedures. Selected participants received a total of four porridge samples, both unfermented and fermented finger and pearl millet porridge for tasting. The sensory profiles were evaluated using nine-point hedonic rating scale to determine the acceptability of fermented millet-based porridge in the home management of diarrhea.

For the sensory evaluation participants were seated in separate, well-lit rooms to prevent any influence by others. The porridges were served in four separate glasses, with intervals of half an hour between each serving. Participants were instructed to sip water in between. Immediately after tasting the porridge, each sample was evaluated for appearance/color, flavor/taste, texture/mouth feel, aroma/odor, and overall acceptability. Ratings were evaluated on a scale from 1 to 9, encompassing preferences from ‘like extremely’ to ' dislike extremely'.

Results and Discussions

Organoleptic properties are the aspects of food, water, or other substances that a person perceives through their senses, which include taste, sight, smell, and touch. The purpose of the sensory evaluation is to describe the product. We recorded acceptable sensory scores that were found to be at par against the fermented and unfermented porridges.

The table 2 presents the results of an independent t-test computed to compare the sensory attributes of unfermented porridge made from pearl millet and finger millet. Each sensory attribute is assessed separately, and the table provides data for the two types of millet: Pearl and Finger millet.

There was a significant difference in the mean scores for the appearance and color of porridge between pearl millet and finger millet. The t-statistic of 2.567 was statistically significant at a p-value of 0.013, indicating that respondents found a difference in appearance between the two types of millet porridge. The higher mean score for finger millet suggests that it was rated more favorably in terms of appearance.

In the case of flavor and taste, the t-statistic of 1.121 is not statistically significant (p-value = 0.267). This suggests that there is no significant difference in the perceived flavor and taste between pearl millet and finger millet porridge. Both types received similar ratings in this aspect.

The t-statistic of 0.957 for mouthfeel was not statistically significant (p-value = 0.343). This indicates that there was no significant difference in the perceived texture and mouthfeel of porridge made from pearl millet and finger millet. Both types received similar ratings in this aspect as well.

The t-statistic of 0.590 for odour was not statistically significant (p-value = 0.558). This suggests that there was no significant difference in the perceived odor of porridge made from pearl millet and finger millet. Both types received similar ratings in this aspect.

The t-statistic of 0.273 for overall acceptability was not statistically significant (p-value = 0.208). This suggests that there is no significant difference in the overall acceptability of porridge made from pearl millet and finger millet. Both types received similar ratings in terms of overall acceptability.

In summary, the results show that while there was a significant difference in the perceived appearance between pearl millet and finger millet porridge, there are no significant differences in flavor, mouthfeel, odour, and overall acceptability. The choice between pearl millet and finger millet for making porridge may depend on individual preferences, with finger millet being favored for its appearance.

The table 3 presents the results of an independent t-test conducted to compare the sensory attributes of fermented porridge made from pearl millet and finger millet. Each sensory attribute was assessed separately, and the table provides data for the two types of millet: Pearl and Finger.

In terms of appearance and color, the t-statistic of 1.580 was not statistically significant (p-value = 0.120). This suggests that there was no significant difference in the perceived appearance of fermented porridge made from pearl millet and finger millet. Both types received similar ratings in this aspect.

There was a significant difference in the mean scores for flavor and taste of porridge between pearl millet and finger millet. The t-statistic of 3.470 was statistically significant at a p-value of 0.001, indicating that respondents found a difference in flavor and taste between the two types of millet porridge. The higher mean score for finger millet suggests that it was rated more favorably in terms of flavor.

The t-statistic of 1.615 for mouthfeel was not statistically significant (p-value = 0.112). This indicates that there was no significant difference in the perceived texture and mouthfeel of porridge made from pearl millet and finger millet. Both types received similar ratings in this aspect as well.

There was a significant difference in the mean scores for odour of porridge between pearl millet and finger millet. The t-statistic of 3.793 was statistically significant at a p-value of 0.000, indicating that respondents found a difference in odor between the two types of millet porridge. The higher mean score for finger millet suggests that it was rated more favorably in terms of odor.

There was a significant difference in the mean scores for overall acceptability of porridge between pearl millet and finger millet. The t-statistic of 4.251 was statistically significant at a p-value of 0.000, indicating that respondents found a difference in overall acceptability between the two types of millet porridge. The higher mean score for finger millet suggests that it was rated more favorably in terms of overall acceptability.

In summary, the results indicate that there were significant differences in the perceived flavor, odour, and overall acceptability of fermented porridge made from pearl millet and finger millet. Finger millet appears to be preferred in terms of these sensory attributes. However, there are no significant differences in appearance and mouthfeel between the two types of millet porridge.

Table 2. Comparison of the sensory attributes between the unfermented pearl and finger millet porridge

Sensory attributes	Millet	N	Mean	Std. Deviation	Std. Error Mean	't'	'p'
Appearance	Pearl	30	6.70	1.022	.187	2.567	.013
	Finger	30	7.33	.884	.161		
Flavour	Pearl	30	6.50	.820	.150	1.121	.267
	Finger	30	6.80	1.215	.222		
Mouthfeel	Pearl	30	6.70	.915	.167	.957	.343
	Finger	30	6.47	.973	.178		
Odour	Pearl	30	6.50	.938	.171	.590	.558
	Finger	30	6.63	.809	.148		
Overall Acceptability	Pearl	30	26.40	2.541	.464	.273	.208
	Finger	30	27.23	2.528	.462		

Table 3. Comparison of the sensory attributes between the fermented pearl and finger millet porridge

Sensory attributes	Millet	N	Mean	Std. Deviation	Std. Error Mean	't'	'p'
Appearance	Pearl	30	7.23	.774	.141	1.580	.120
	Finger	30	7.57	.858	.157		
Flavour	Pearl	30	7.00	.983	.179	3.470	.001
	Finger	30	7.83	.874	.160		
mouthfeel	Pearl	30	6.87	.860	.157	1.615	.112
	Finger	30	7.23	.898	.164		
Odour	Pearl	30	6.47	.776	.142	3.793	.000
	Finger	30	7.17	.648	.118		
Overall Acceptability	Pearl	30	27.57	1.995	.364	4.251	.000
	Finger	30	29.80	2.074	.379		

Table 4. Comparison of the sensory attributes between the unfermented and fermented pearl millet porridge

Sensory attributes	Fermentation	N	Mean	Std. Deviation	Std. Error Mean	't'	'p'
Appearance	Unfermented	30	6.70	1.022	.187	2.279	.026
	Fermented	30	7.23	.774	.141		
Flavour	Unfermented	30	6.50	.820	.150	2.140	.037
	Fermented	30	7.00	.983	.179		
Mouthfeel	Unfermented	30	6.70	.915	.167	.727	.470
	Fermented	30	6.87	.860	.157		
Odour	Unfermented	30	6.50	.938	.171	.150	.881
	Fermented	30	6.47	.776	.142		
Overall Acceptability	Unfermented	30	26.40	2.541	.464	1.978	.053
	Fermented	30	27.57	1.995	.364		

Table 5. Comparison of the sensory attributes between the unfermented and fermented finger millet porridge

Sensory attributes	Fermentation	N	Mean	Std. Deviation	Std. Error Mean	't'	'p'
Appearance	Unfermented	30	7.33	.884	.161	2.279	.026
	Fermented	30	7.57	.858	.157		
Flavour	Unfermented	30	6.80	1.215	.222	2.140	.037
	Fermented	30	7.83	.874	.160		
Mouthfeel	Unfermented	30	6.47	.973	.178	.727	.470
	Fermented	30	7.23	.898	.164		
Odour	Unfermented	30	6.63	.809	.148	.150	.881
	Fermented	30	7.17	.648	.118		
Overall Acceptability	Unfermented	30	27.23	2.528	.462	1.978	.053
	Fermented	30	29.80	2.074	.379		

The table 4 provides the results of an independent t-test comparing sensory attributes between unfermented and fermented pearl millet porridge. The attributes assessed include Appearance, Flavour, Mouthfeel, Odour, and Overall Acceptability.

There was a significant difference in the mean scores for the appearance and color of porridge between unfermented and fermented varieties. The t-statistic of 2.279 is statistically significant at a p-value of 0.026, indicating that respondents found a difference in appearance between the two types of porridge. Fermented porridge is rated higher in terms of appearance.

There was a significant difference in the mean scores for flavor and taste between unfermented and fermented porridge. The t-statistic of 2.140 is statistically significant at a p-value of 0.037, indicating that respondents found a difference in flavor between the two types of porridge. Fermented porridge is rated higher in terms of flavor.

The t-statistic of 0.727 for mouthfeel was not statistically significant (p-value = 0.470). This suggests that there is no significant difference in the perceived texture and mouthfeel of unfermented and fermented porridge. Both types received similar ratings in this aspect.

The t-statistic of 0.150 for odour was not statistically significant (p-value = 0.881). This suggests that there is no significant difference in the perceived odor of unfermented and fermented porridge. Both types received similar ratings in this aspect.

The t-statistic of 1.978 for overall acceptability was not statistically significant, although it is close to the significance level (p-value = 0.053). This suggests that there is a potential difference in the overall acceptability of unfermented and fermented porridge, but it doesn't reach statistical significance at the chosen significance level. Hence both fermented and unfermented porridges are equally acceptable to the panelists.

In summary, the results indicate that there were significant differences in the perceived appearance and flavor of porridge between unfermented and fermented varieties. Fermented porridge is preferred in terms of these sensory attributes. However, there are no significant differences in mouthfeel, odour and overall acceptability between the two types of porridge.

The table 5 provides the results of an independent t-test comparing sensory attributes between unfermented and fermented finger millet porridge. The sensory attributes assessed include Appearance, Flavour, Mouthfeel, Odour and Overall Acceptability.

There was a significant difference in the mean scores for the appearance and color of finger millet porridge between unfermented and fermented varieties. The t-statistic of 2.279 is statistically significant at a p-value of 0.026, indicating that respondents found a difference in appearance between the two types of porridge. Fermented finger millet porridge is rated higher in terms of appearance.

There was a significant difference in the mean scores for flavor and taste of finger millet porridge between unfermented and fermented varieties. The t-statistic of 2.140 is statistically significant at a p-value of 0.037, indicating that respondents found a difference in flavor between the two types of porridge. Fermented finger millet porridge is rated higher in terms of flavor.

The t-statistic of 0.727 for mouthfeel was not statistically significant (p-value = 0.470). This suggests that there is no significant difference in the perceived texture and mouthfeel of unfermented and fermented finger millet porridge. Both types received similar ratings in this aspect.

The t-statistic of 0.150 for odour was not statistically significant (p-value = 0.881). This suggests that there is no significant difference in the perceived odor of unfermented and fermented finger millet porridge. Both types received similar ratings in this aspect.

The t-statistic of 1.978 for overall acceptability was not statistically significant, although it is close to the significance level (p-value = 0.053). This suggests that there is a potential difference in the overall acceptability of unfermented and fermented finger millet porridge, but it doesn't reach statistical significance at the chosen significance level.

In summary, the results indicate that there were significant differences in the perceived appearance and flavor of finger millet porridge between unfermented and fermented varieties. Fermented finger millet porridge is preferred in terms of these sensory attributes. However, there are no significant differences in mouthfeel, odour, and overall acceptability between the two types of porridge.

Karuppasamy and Veena (2019) carried out the formulation of small millet porridge by the standard procedure incorporating kodo millet, little millet and foxtail millet varieties at 50, 75 and 100 per cent levels. The sensory attributes viz., colour and appearance, flavour, texture and taste were evaluated for the millet samples. The score values were observed to be maximum at 100 per cent incorporation level. Porridge developed from Foxtail millet samples were also found to be highly acceptable at 100 percent incorporation level based on the scores obtained for the sensory attributes. The colour and appearance of samples increased in the score value with the increase in the incorporation of foxtail millet flour.

Conclusion

From ancient times, fermented foods are integral to the diet in South India, with Lactic Acid Bacteria playing a crucial role in their production and preservation (Satish Kumar et al. 2010). Fermented millet porridge, known as koozh, particularly finger millet and pearl millet has been a staple in rural diets for generations. Its antimicrobial properties, due to the production of bacteriocins, hold special significance in regions with limited access to clean water and poor sanitation, especially in underdeveloped and congested residential areas in urban region (Ilango et al., 2016). The study results on supplementation of fermented gruels among children with diarrheal episodes showed that the mean number of diarrhoeal episodes in a group of pre-school children over a 9-month period was 2.1 per child using fermented gruels, compared with 3.5 per child using non-fermented gruels ($p<0.001$) (Lorri and Svanberg, 1995).

Kumar et al. (2010) have studied the microflora of koozh prepared from finger millet under laboratory conditions, with fermentation for 2 days without the addition of cooked broken rice and reported the presence of Weisella paramesenteroides with probiotic properties and Lactobacillus fermentum with antibacterial activity towards Salmonella typhi, Vibrio parahaemolyticus and Listeria monocytogenes. A systematic review by Olayanju et al. (2023) found that fermented food consumption can effectively reduce the duration of diarrhea and hospitalization in children under five.

Thus, fermented finger millet based porridge which is a locally available inexpensive traditional food acts as a promising probiotic option that could be popularized among mothers for feeding their children, both before and during diarrheal episodes as indicated by the sensory profiling. This aligns with numerous studies highlighting the probiotic benefits of fermented foods.

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