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Formulation and Evaluation of Millet Extract Enriched Yoghurt

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Abstract

Yoghurt is a cultured milk product obtained by lactic acid fermentation through the action of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* and resulting in reduction of pH with coagulation. Minor millets are cited as important addendum for major cereals. The pearl millet is nutritionally superior to major cereal crops with respect of energy value, proteins, fat and minerals. Blending of millet grains or their milling fractions combined with other treatment is one of the most convenient techniques to produce food products with high nutritional value and functionality and to promote their utilization in a large range of food products. Hence the present study was done to formulate and evaluate standardized yoghurt with incorporation of pearl millet extract at 10%, 20% and 30% respectively and to assess the organoleptic, physiochemical and microbiological values of highly acceptable value enriched yoghurt stored in various containers. Results showed that 10% pearl millet extract incorporated yoghurt stored in plastic container secured high scores in organoleptic evaluation. Shelf life evaluation showed that the microbial load was within the limit as per FSSAI standards in both standard and millet extract enriched yoghurt stored in plastic container and in mud pot.

Keywords: Organoleptic Evaluation, Pearl Millet Extract, Physiochemical Analysis, Shelf Life Evaluation, Value Addition, Yoghurt

1. Introduction

Fermented milks have been developed throughout the world as a means of preserving milk against spoilage. Fermented milks are popular in view of organoleptic and other properties such as the characteristic flavour, refreshing taste and improved digestibility. The composition of fermented milks can be easily tailored to meet various dietary requirements especially in the production of low calorie fermented milks[1]. Yoghurt, a nutrient-dense food is one of the most prevalent fermented milk products worldwide[2]. According to the Code of Federal Regulations of the FDA yoghurt is the food produced by culturing one or more of the optional dairy ingredients with a characterizing bacterial culture that contains the lactic acid-producing bacteria[3]. Value addition and improving health benefits of milk by combining with millets extract by applying advanced technologies for their processing and preservation opens new avenues for the product diversification. Keeping in view these facts, the present research work is aimed at formulation and evaluation of millet extract enriched yoghurt with the following objectives:

- To standardize the percentage of incorporation of millet extract in yoghurt.
- To organoleptically evaluate the millet extract incorporated yoghurt.

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- To analyze the nutritional, physiochemical, microbial and sensory qualities of millet extract incorporated yoghurt.
- To study the shelf life of highly accepted millet extract enriched yoghurt stored in food grade plastic containers and mud pots.

2. Materials and Methods

Standardized milk was purchased from Aavin, Tamil Nadu Milk Society, Erode, Skim milk powder, good quality of sugar, Pearl millet (*Pennisetum glaucum*) were procured from the super market, Erode. The freeze dried yoghurt starter culture containing *Streptococcus thermophiles*, *Lactobacillus bulgaricus* and *Lactocillus acidophilus* (yogourmet) were purchased from LYO – SAN INC, Canada. The packaging material used for packaging of the developed value enriched yoghurt was basically polypropylene cups and earthen mud pot which was procured from the local market in Erode.

2.1 Preparation of Millet Extract

Pearl millet was washed well with fresh water to remove dirt and soaked in water for about 12 hours and allowed to germinate for 24 hours. The sprouted millet was ground well using mixer grinder for milk extraction. Sprouted millet and water were taken in the ratio of 1:2 for grinding and the extract was filtered using muslin cloth for clarification.

2.2 Preparation of Yoghurt

Pasteurized milk was heated to 90-95°C for 5 minutes and cooled to 42°C and milk was inoculated with starter culture at the rate of 2% and were incubated undisturbed to produce set yoghurt. The raw milk was divided into four lots namely, control and three experimental groups prior to the addition of starter culture about 10%, 20% and 30% (pearl millet extract) was added to the experimental milk samples separately. Then the control and sample were incubated at 42°C until coagulation then cooled and stored in a refrigerator at 4°C (Figure 1).

2.3 Analysis of Value Enriched Yoghurt

The highly acceptable value enriched yoghurt among 10%, 20% and 30% addition of sprouted pearl millet extract were packed in plastic container and earthen pots without addition of preservative and was stored for a period of one week at refrigerated temperature (4-7°C).

Microbial analysis of standard and highly acceptable value enriched yoghurt was carried out after a storage period of one week at refrigerator temperature. Total plate count, coliform count, yeast and mold count of sample were enumerated on alternative days (0^{th}, 3^{rd}, 5^{th} and 7^{th}) of storage period.

Physico chemical parameters like total solids were analyzed by hot air oven method, pH by using digital pH meter, titratable acidity by titrating hydroxide with against 0.1 N sodium phenolphthalein as an indicator. Syneresis was analyzed using drainage method. Protein was estimated by lowery's method, fat was determined by Rose-Gottlieb method, determination of ash, calcium and iron was done by AOAC method.

The value enriched yoghurt samples were prepared and presented to 15 semi trained panel of judges to access colour and appearance, body and texture, flavour, sourness using 9 point hedonic scale.

3. Results and Discussion

3.1 Organoleptic Evaluation of Formulated Value Enriched Yoghurt

From the Table 1 it is noted that the scores for the sensory attributes like color and appearance, body and texture, flavour and sourness of standard yoghurt were higher than all the variations of pearl millet extract yoghurt. The mean colour and appearance scores of 10% and 20% pearl millet extract incorporated yoghurt were almost similar. However, the mean colour and appearance scores decreased with 30% pearl millet extract incorporation in yoghurt. The mean flavor scores for 10% pearl millet extract incorporated yoghurt was 8.5 ± 0.5 followed by 7.5 ± 0.5, 5.6 ± 0.5 of 20% and 30% pearl millet extract incorporated yoghurt respectively. Among the variation, 10% pearl millet extract incorporated yoghurt was highly acceptable.

From the Table 2 it is noted that the mean overall acceptability scores of standard yoghurt and 10% pearl millet extract incorporated yoghurt stored in plastic

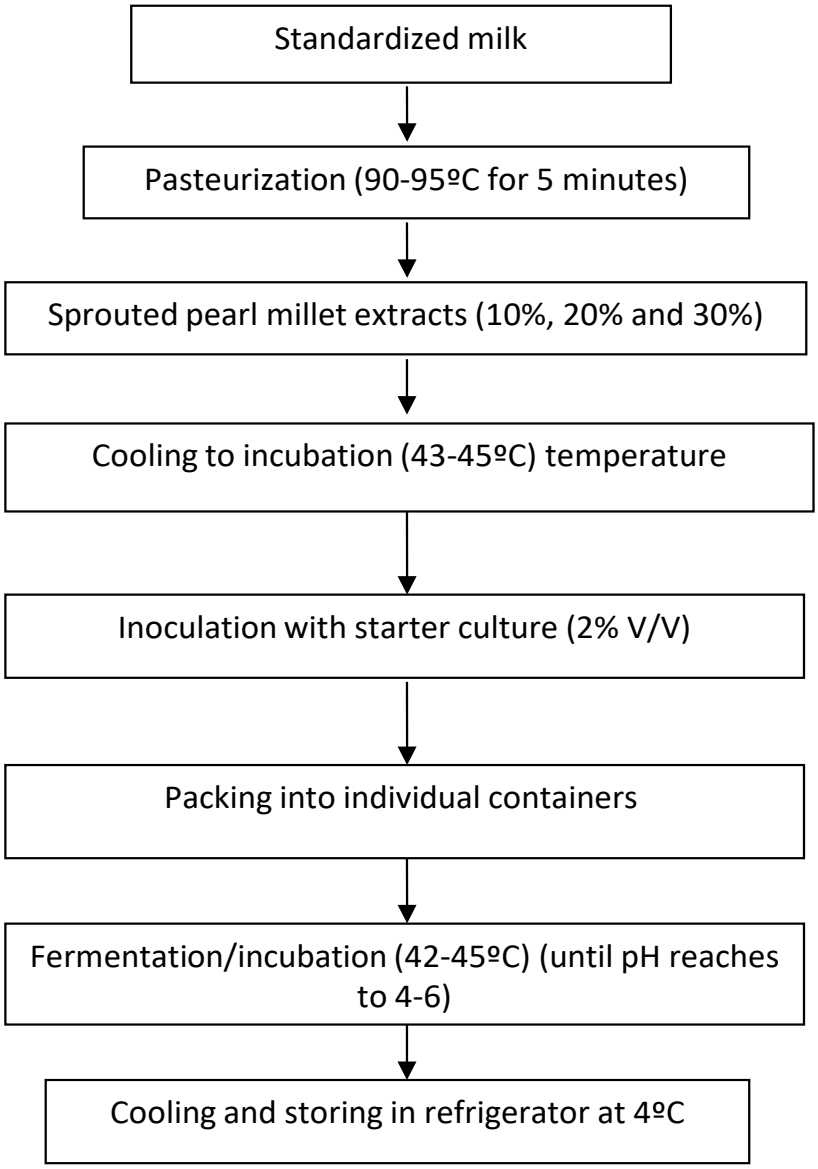

Figure 1. Manufacture of value enriched yoghurt.

container was found to be maximum (9.0 ± 0.0) on initial day. Statistical analysis of 't' value for mean overall acceptability scores did not reveal any significant difference at 5% level between standard yoghurt and 10% pearl millet extract yoghurt stored in plastic container on initial day, 3rd day, 5th day and 7th day of storage.

The mean overall acceptability score of standard yoghurt was (9.0 ± 0) and 10% pearl millet extract incorporated yoghurt was (8.93 ± 0.25) when stored in mud pot on initial day. The statistical analysis of 't' value for mean overall acceptability scores between the standard yoghurt and 10% pearl millet extract incorporated yoghurt stored in mud pot showed significant difference at 5% level on 3rd, 5th and 7th day of storage.

Table 1. Mean acceptability scores of standard yoghurt and pearl millet extract incorporated yoghurt

Variations	Mean ± SD			
	Colour and Appearance	**Body and Texture**	**Flavour**	**Sourness**
Standard	8.7 ± 0.5	8.8 ± 0.4	8.8 ± 0.4	8.6 ± 0.6
PMEY 10%	8.7 ± 0.5	8.7 ± 0.5	8.5 ± 0.5	8.5 ± 0.5
PMEY 20%	8.5 ± 0.5	7.7 ± 0.5	7.5 ± 0.5	7.2 ±0.9
PMEY 30%	8.2 ± 0.9	5.8 ± 1.1	5.6 ± 0.5	4.5 ± 1.1

PMEY – Pearl Millet Extract incorporated Yoghurt

Table 2. Mean overall acceptability scores of standard yoghurt and 10% pearl millet extract yoghurt on storage

Variation	Storage days	Standard	10% PMEY	t-value
Plastic cup	**0th**	9.0 ± 0.0	9.0 ± 0.0	0^{ns}
	3rd	9.0 ± 0.0	8.91 ± 0.26	0.99^{ns}
	5th	8.85 ± 0.35	8.81 ± 0.35	0.25^{ns}
	7th	8.78 ± 0.41	8.45 ± 0.48	2.03^{ns}
Mud pot	**0th**	9.0 ± 0	8.93 ± 0.25	0.99^{ns}
	3rd	8.93 ± 0.25	8.53 ± 0.48	2.84*
	5th	8.71 ± 0.45	7.9 ± 0.32	5.48*
	7th	8.58 ± 0.49	7.73 ± 0.59	4.25*

ns – no significant difference at 5% level.

*- significant difference at 5% level.

PMEY - Pearl Millet Extract Incorporated Yoghurt.

3.2 Physiochemical Analysis of Value Enriched Yoghurt

The pH values of all samples decreased during storage in different packaging material accompanied by an increase in alcoholic aroma and acidic taste. During fermentation the lactic acid bacteria produces lactic acid from milk

lactose thus lowers the pH and shows steady decline throughout the storage time[4]. From the Table 3 and Figure 2 it is evident that the standard and 10% pearl millet extract incorporated yoghurt stored in plastic container and in mud pot showed relatively similar pH value on the initial day. The pH value decreases with increasing in storage period. The pH value decreased to 4.1 ± 0.0 from 4.4 ± 0.0 in standard and 10% pearl millet extract incorporated yoghurt stored in plastic container and 4.5 ± 0.0 to 4.1 ± 0.0 in standard yoghurt stored in mud pot and 4.4 ± 0.0 to 4.0 ± 0.0 in 10% pearl millet extract incorporated yoghurt stored in mud pot. Table 3 and Figure 3 also revealed that the titratable acidity increases by increasing storage days in both storage containers. The least titratable acidity value was obtained by standard yoghurt stored in mud pot and maximum value was secured by 10% pearl millet extract incorporated yoghurt stored in mud pot on initial day and on 7th day of storage. Further, the 10% pearl millet extract incorporated yoghurt secured highest titratable acidity value among all the variations.

Syneresis is the oozing out of liquid from yoghurt it is one of the primary parameter for checking yoghurt quality low quality yoghurt shows high syneresis. From the Table 4 and Figure 4 it is noted that the syneresis value of the standard yoghurt and 10% pearl millet extract yoghurt stored in plastic container and mud pot. Syneresis value increases by increasing storage days irrespective of storage containers. The fresh control yoghurt and 10% pearl millet extract yoghurt stored in plastic container and mud pot showed a syneresis value of 19.3 ± 0.3, 18.8 ± 0.3, 16.3 ± 0.6 and 17.2 ± 0.3 respectively. At the end of the 6 days of storage, the yoghurt sample stored in food grade plastic started showing increased syneresis. On the 7th day of storage the standard yoghurt stored in mud pot showed the least syneresis level (23 ± 0.6) among all the yoghurt samples.

Table 3. pH and titratable acidity value of standard yoghurt and value enriched yoghurt on storage

Storage period (Day)	pH				Titratable acidity			
	Stored in plastic container*		Stored in mud pot*		Stored in plastic container*		Stored in mud pot*	
	Standard yoghurt	1 % PMEY	Standard yoghurt	10% PMEY	Standard yoghurt (% LA)	10% PMEY (% LA)	Standard yoghurt (% LA)	10% PMEY (% LA)
0	4.4 ± 0.0	4.4 ± 0.0	4.5 ± 0.0	4.4 ± 0.0	0.86± 0.0	0.86 ± 0.0	0.81 ± 0.0	0.88 ± 0.0
3	4.4 ± 0.0	4.3 ± 0.0	4.3 ± 0.0	4.3 ± 0.0	0.86 ± 0.0	0.89 ± 0.0	0.85 ± 0.0	0.97 ± 0.0
5	4.4 ± 0.0	4.3 ± 0.0	4.3 ± 0.0	4.2 ± 0.0	0.88 ± 0.0	0.97 ± 0.0	0.86 ± 0.0	0.99 ± 0.0
7	4.1 ± 0.0	4.1 ± 0.0	4.1 ± 0.0	4.0 ± 0.0	0.95 ± 0.0	1.04 ± 0.0	0.93 ± 0.0	1.03 ± 0.0

*Average of three trails

PMEY –Pearl Millet Extract Incorporated Yoghurt

Table 4. Syneresis value of standard yoghurt and value enriched yoghurt

Storage period (Day)	Stored in plastic container*		Stored in mud pot*	
	Standard yoghurt	10% PMEY	Standard yoghurt	10% PMEY
0	19.3 ± 0.3	18.8 ± 0.3	16.3 ± 0.6	17.2 ± 0.3
3	24 ± 0.9	21.3 ± 0.3	18.3 ± 0.6	20 ± 0.5
5	27 ± 0.6	23.2 ± 0.1	21 ± 0.0	20.9 ± 0.2
7	27.2 ± 0.3	26.1 ± 0.2	23 ± 0.6	24.7 ± 0.6

*Average of three trails

PMEY – Pearl Millet Extract Incorporated Yoghurt.

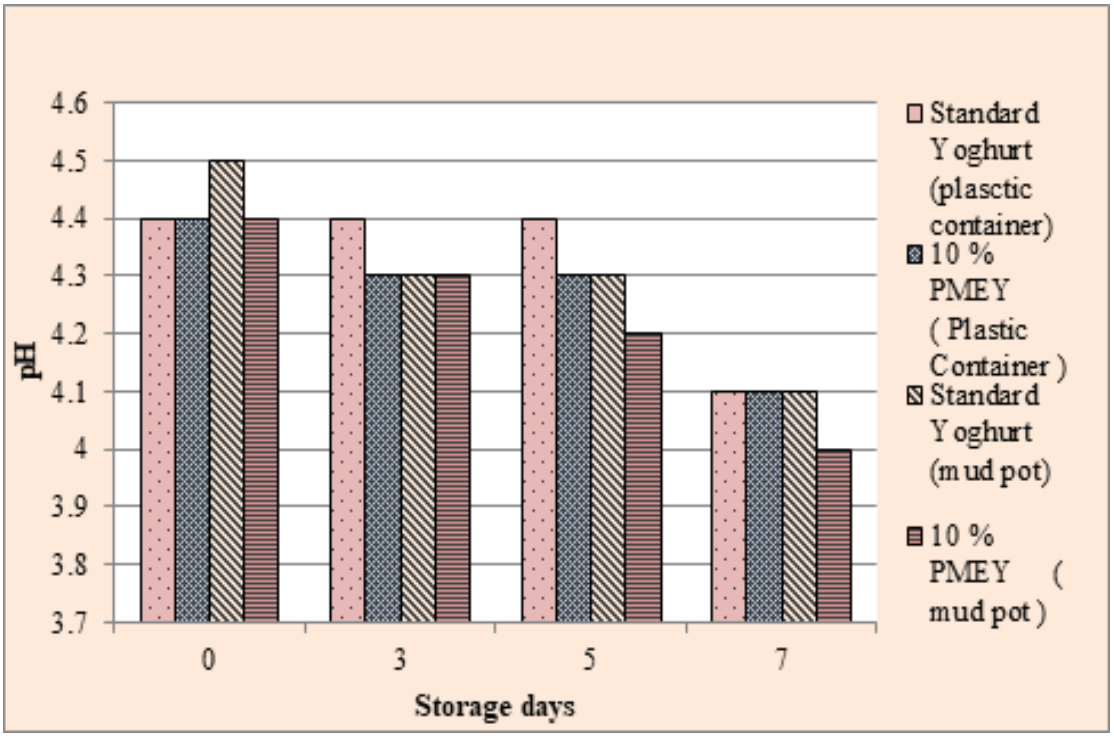

Figure 2. pH of standard yoghurt and 10% pearl millet extract yoghurt on storage.

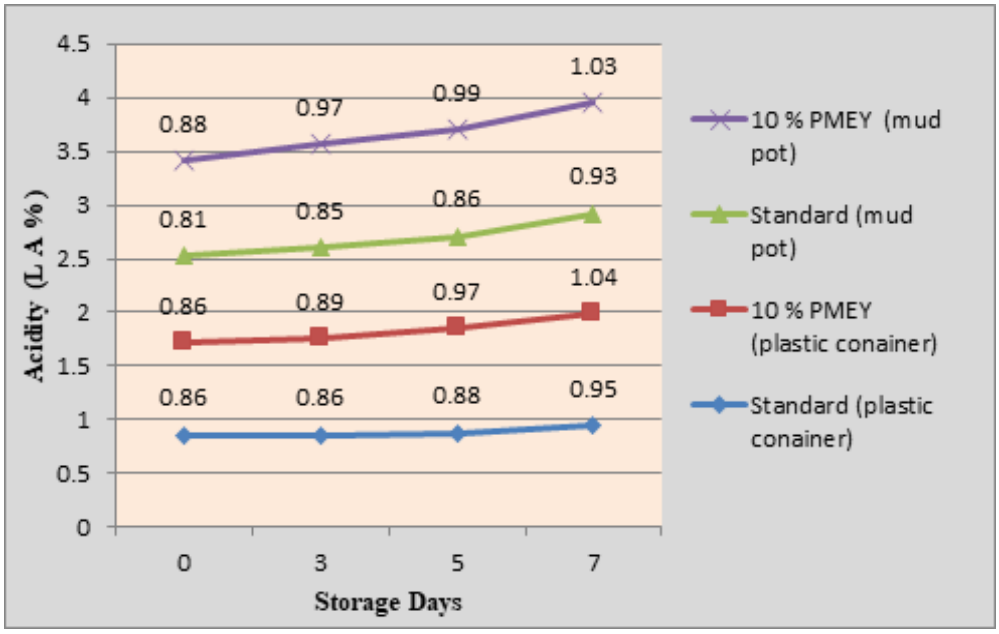

Figure 3. Titratable acidity of standard yoghurt and 10% pearl millet extract yoghurt on storage.

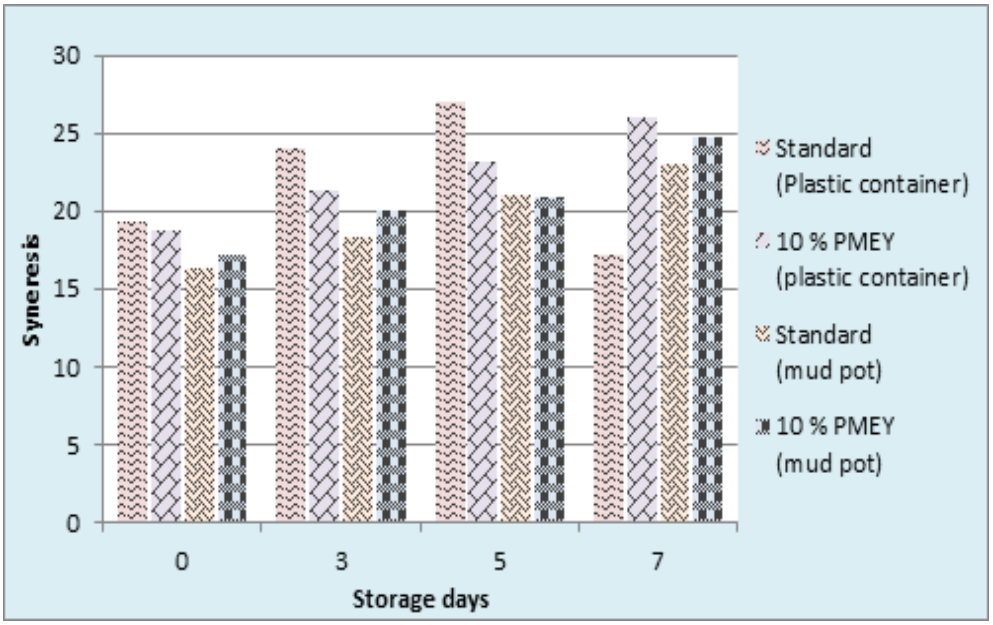

Figure 4. Syneresis of standard yoghurt and 10% pearl millet extract yoghurt on storage.

3.3 Microbial Analysis

The yoghurts containing live probiotics converse health benefits to the host when they are consumed in suitable quantity. It is essential for probiotic cultures to survive in yoghurts during their shelf life before they are consumed[5]. From the Table 5 it was evident that there was an increase in number of total bacterial count during storage conditions in standard yoghurt and 10%

Table 5. Microbial analysis of standard yoghurt and value enriched yoghurt

Microbes	Storage Days	Packaging material			
		Plastic container (Std)	Plastic container (10% PMEY)	Mud pot (Std)	Mud pot (10% PMEY)
Total bacterial count	0th day cfu/g	5.4 X 10^4	8.0 X 10^4	5.6 X 10^4	9.1 X 10^4
	3rd day cfu/g	5.7 X 10^4	8.5 X 10^4	5.9 X 10^4	9.7 X 10^4
	5th day cfu/g	6.4 X 10^4	8.9 X 10^4	6.7 X 10^4	10.2 X 10^4
	7th day cfu/g	6.9 X 10^4	9.3 X 10^4	7.2 X 10^4	10.7 X 10^4
Coliform count	0th day cfu/g	Nil	Nil	Nil	Nil
	3rd day cfu/g	Nil	Nil	Nil	Nil
	5th day cfu/g	Nil	Nil	Nil	Nil
	7th day cfu/g	Nil	Nil	Nil	Nil
Yeast and mold count	0th day cfu/g	Nil	Nil	Nil	Nil
	3rd day cfu/g	Nil	Nil	Nil	Nil
	5th day cfu/g	Nil	Nil	Nil	Nil
	7th day cfu/g	Nil	Nil	Nil	Nil

PMEY – Pearl Millet Extract incorporated Yoghurt

pearl millet extract yoghurt. The level of total bacterial count increased in value added yoghurt than standard yoghurt due to incorporation of 10% pearl millet extract, however the levels of the bacterial count was within the recommended standards. The standard yoghurt and 10% pearl millet extract incorporated yoghurt stored in various packaging material had no evidence of coliform bacteria. Maximum count of 10 cfu/g of coliform bacteria was allowed in yoghurt[6] so, the samples with less value than 10 cfu/g were justified suitable and safe for human consumption. Absence of coliform bacteria is due to good hygienic practices during the yoghurt manufacturing in this study. The absence of coliform bacteria helps to increase the shelf life of the products.The undesirable level was notified as (>10^2cfu.g^{-1}) for yeast and mold in yoghurt[7]. The standard yoghurt and 10% pearl millet extract incorporated yoghurt packed in various packaging material (Table 5) revealed absence of yeast and mold due to proper storage and hygienic packaging and absence of cross contamination during the process of manufacturing yoghurt in this study.

4. Conclusion

From the above study it was concluded that among all the variations 10% pearl millet extract incorporated yoghurt was highly acceptable and it can be stored safely

in refrigerator for 7 days. The mean overall acceptability was found to be maximum in 10% pearl millet extract incorporated yoghurt stored in plastic container compared to 10% pearl millet extract incorporated yoghurt stored in mud pot. This is due to decreased acidity of yoghurt stored in plastic container.

5. References

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