Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.67, 2017

Development of Fruit Flavored Yoghurt with Mango (Mangifera indica L.) and Papaya (Carica papaya L.) Fruits Juices

Getenesh Teshome[1*] Abdi Keba[1] Zerihun Assefa[1] Bilatu Agza[2] Firew Kassa[1]
1.Holeta Agricultural Research Center P. O. Box 31. Holeta, Ethiopia
2.Ethiopian Institute of Agricultural Research P. O. Box 2003. Addis Ababa, Ethiopia

Abstract
This study was carried out to develop and evaluate physico-chemical property, microbial quality and sensory acceptance of fruit flavored yogurt and plain yoghurt. Fruit flavored yogurt with two different fruit juice types: mango and papaya were prepared with different proportions. Each of the fruit juices were added to yoghurt at the rate of 10%, 15%, 20%, 25%. Fruit flavored yoghurt and plain samples (no fruit juice added) were analyzed for physico-chemical and microbial quality and sensorial acceptance. Addition of fruit juice concentrations significantly ($p<0.05$) affected the physico-chemical and sensorial properties and microbial quality of fruit flavored yoghurt samples. There were significant differences between control yogurt and fruit flavored yogurt in the pH, titratable acidity, ash, fat, protein, and total solid content. The result of this study indicates that, titratable acidity increased with increased fruit percentage. However, protein, fat, ash and total solid content of fruit flavored yoghurt were decreased as compared to the plain yoghurt. The lactic acid bacteria count was significantly higher in plain yoghurt; however, the total aerobic mesophilic bacteria, coliform count and yeast and molds were higher in fruit flavored yoghurt. Fruit flavored yoghurt incorporated with 15% of mango juice was the most preferred one as compare to the other treatments. The results of current study confirm that, addition of fruit juice to the yogurt significantly improved the sensorial acceptability and physico-chemical properties of yoghurt.
Keywords: Fruit-flavored yoghurt, Mango, Microbial quality, Sensory quality, Physico-chemical properties, Papaya

Introduction

Yoghurt is a dairy product obtained from the lactic acid fermentation of milk. It is one of the most popular fermented milk products in the world (Willey *et al.,* 2008). The use of yogurt dates back many centuries, although there is no accurate record of the date when it was first made. Yoghurt can be good sources of essential nutrients as minerals in the human diet. It could contribute significantly to the recommended daily requirements for calcium and magnesium to maintain the physiological process (Sanchez *et al*., 2000).

An increasing demand can be seen for fruit yogurts. Introduction of various fruit-flavored yogurts has significantly contributed to the consumption of yogurt among all ages (Chandan *et al.,* 1993). There could be many reasons behind this. Incorporation of fruits endorses the healthy image of yogurt. Bardale *et al.,* (1986), reported that the addition of fruit preparations, fruit flavors, fruit purees, and flavor extracts enhances versatility of taste, color, and texture for the consumer. Sensory appeal also is one of the essential strategies associated with market success of fermented product like yoghurt. The popularity of yoghurt as a food component has been linked to its sensory characteristics (Routray and Mishra, 2011). The key to the increase in sales of yoghurt is a continuous evaluation and modification of the product to match consumer expectations (Alan Hugunin, 1999).

Papaya and Mango are not only easily available and mostly consumed fruits in high amount but also they are rich in β- carotene, lycopene, phenol, anti-oxidants and minerals. In addition to this Papaya is characterized by high amount of proteolytic enzyme like papain and chmyopapain, which help in digestion (Starleya, 1999). Research works on developing fruit based yogurt have not yet been done in Ethiopia. Therefore, the aim of this study was to develop fruit flavored yogurts supplemented with mango and papaya juices and to evaluate the sensory acceptance, physico-chemical and microbial quality.

3. Materials and methods

3.1 Raw material preparation

The experiment was conducted in the dairy laboratory of Holeta Agricultural Research Center. In this study two types of fruits (papaya and mango) were used with different proportion to develop flavored yoghurt (fruit flavored mango and fruit flavored papaya) production. Fresh cow milk was collected from dairy farm of Holeta Agricultural Research Center for yoghurt preparation and fruits (mango and papaya), and starter culture were collected from local supermarket.

3.2 Preparation of fruit juice and fruit flavored yoghurt

Ripened Mango and Papaya fruits were washed and peeled by knife aseptically. Fruit juices were extracted and homogenized by juice maker and homogenizer (POLYTRON, Switzerland). Both mango and papaya juices were filtered by clean cheese cloth and kept in the refrigerator (4°C) in the sterilized glass bottle. Yoghurt was manufactured according to International Dairy Federation's yoghurt manufacture procedures (IDF 1988). Fresh cow milk was used for yoghurt production. Briefly, the milk was filtered to remove foreign matters and pasteurized at 72^{o}C for 15 seconds to reduce pathogenic microorganism. Then, milk temperature was cooled to 42^{o}C. Following that, 3% of starter culture was added in to pasteurized milk and prepared fruit juices (mango and papaya) were added to yoghurt at the rate of 10%, 15%, 20% and 25%. Then, the cup of fruit flavored yoghurt and plain yoghurt (no added fruit juice) were incubated at 42^{o}C until complete coagulation of yoghurt for 5-6 hours. After complete coagulation, all treatments were cooled in the refrigerator at 4^{o}C until sensory evaluation, physico-chemical and microbial analysis were carried out.

3.3 Sensory quality evaluation of fruit flavored yoghurt

Prepared fruit flavored yoghurt were subjected to sensory evaluation by ten semi- trained panelists. The panelists comprised of female and male members who had previous experience on milk and milk products evaluation. The evaluation of fruit flavored yoghurt was carried out on color, flavor, taste, odor and overall acceptability. Evaluation was done at room temperature in Holeta Dairy Research Laboratory. Each panelist scored samples independently and recorded the scores on the sheets provided. Five-point hedonic scale (1= dislike extremely, 2= dislike moderately, 3= neither dislike nor like, 4= like moderately and 5= like extremely) was used to rank plain yoghurt and fruit flavored yoghurt. Panelists were served water and unsalted crackers to clean their mouths before tasting each sample (Bodyfelt *et al.*, 1988).

3.4 Physico-chemical analysis of fruit flavored yoghurt

Titratable acidity (expressed as % lactic acid) of flavored yoghurt was determined by titration with 0.1N sodium hydroxide solution; using phenolpeltalein as indicator according to the procedure by O'Connor (1994). Total solids (TS) of freshly prepared flavored yoghurt and plain yoghurt samples were measured oven drying at 105°C until steady weight was achieved (approximately overnight) according to O'Connor (1994). The pH value of the samples were measured by pH meter(pH-016, China) Ash content of the samples were measured gravimetrically by using dried portion of total solid in the muffle furnace by igniting at 550°C for 5 hours according to "Standard Methods for the Examination of Dairy Products" (Michael and Frank 2004). Fat content of samples were measured by Gerber method according to the procedures by O' Connor (1994). The protein contents of sample were determined by using Association of Official Analytical Chemist (AOAC, 2005).

3.5 Microbial Analysis

3.5.1 Total aerobic mesophilic bacteria count

A total aerobic mesophilic bacterial count was done according to (FAO 1997**)** using plate count agar (Oxoid, CM 0325). One ml of yogurt samples was homogenized using vortex mixer (VM-300, Taiwan) with 9 ml sterile peptone water to obtain first dilution. One ml of the sample from a selected dilution was pour-plated in duplicate and incubated for 48±2 hours at 35°C. The enumeration of bacteria was performed using digital colony counter and the result was expressed as colony forming units per ml (CFU/ml).

3.5.2 Total coliform count

Total coliform count was done according to Standard Methods for Examination of Dairy products (Michael and Frank 2004). The media was prepared according to manufactures instructions. One ml sample of homogenized was taken from appropriate serial dilutions and plated on violet red bile agar (Oxoid, CM 0107) in duplicate, and incubated at 32°C for 24 hours. The enumeration of total coliform was performed using digital colony counter and the result was expressed as colony forming units per ml (CFU/ml).

3.5.3 Yeast and mould count

Yeast and mould count was carried out according to FAO (1997). Homogenized samples were serially diluted by adding 1 ml of sample into 9 ml of peptone water (Oxoid, CM0009). Potato Dextrose Agar (Himedia, M096) media was prepared according to manufactured instruction and antibiotics (Streptomycin and Chloramphenicol) were added to inhibit the growth of bacteria. One ml of homogenized sample was taken and plated on prepared PDA media in duplicate. The enumeration of yeast and mould was performed and the result was expressed as colony forming units per ml (CFU/ml).

3.5.4 Lactic acid bacteria count

Lactic acid bacterial count was done according to Standard Methods for the Examination of Dairy Products (Michael and Frank 2004) using lactobacillus MRS agar (Himedia, M641). One ml of each yogurt sample was homogenized using vortex mixer (VM-300, Taiwan) with 9 ml sterile peptone water (Oxoid, CM0009). Then, one ml of homogenized sample from appropriate serial dilutions was poured-plated on the melted MRS agar in duplicate. It was then incubated in anaerobic jars at 35°C±2 for 48 hours. Colonies of lactic acid bacteria were counted and expressed as colony forming units per ml (CFU/ml).

3.6 Statistical Analysis

Physico-chemical and microbial data were analyzed using the general linear model (GLM) procedure of the Statistical Analysis System (SAS) and means were compared using Duncan's Multiple Range Test (SAS Inc., Cary, USA) version 9. The microbial count results were log transformed before the statistical analysis. Sensory data was analyzed using Kruskal -Wallis test of the SPSS statistical package program (SPSS, Inc., Chicago, IL, USA) version 20.

4. Result and Discussion

4.1 Physico-chemical properties of fruit flavored yogurt

4.1.1 Titratable acidity and pH

Mean of titratable acidity and pH of control and fruit flavored yoghurts are presented in (Table2**).** The effect of different fruit flavors on pH and titratable acidity were highly significant ($p<0.001$). Addition of fruit decreased the pH in yoghurt. Whereas, titratable acidity increased with increased fruit percentage. Similar observation was reported by Debashis *et al.,* (2016) who reported that, the acidity of yoghurt was increased with increasing of banana, papaya and watermelon percentages. The result of this study indicates that, 25% mango flavored yoghurt had the highest titratable acidity, but it had lowest pH (3.92).

4.1.2 Fat and Protein content of fruit flavored yoghurt and plain yoghurt

Mean of fat and protein content of control and fruit flavored yoghurts are presented in table 2**.** The effect of fruit on yoghurt fat and protein contents were highly significant ($p<0.001$). It was obtained that change in fat and protein contents in yoghurt samples was highly influenced by adding fruit juice. The protein and fat contents in yoghurt samples decreased with increasing fruit juice percentage. This might be attributed to the low protein and fat contains of fruit as compare to milk. This finding agrees with the work of Debashis *et al.,* (2016) who reported that, the fat and protein content of yoghurt decreased with increase of banana, papaya and watermelon pulp percentages. Similar finding was also reported by Hossain *et al.,* (2012) who found that, the fat and protein content of fruit yoghurt decreased with increase of strawberry, orange and grape percentages. The result of our study indicates that, the maximum and minimum fat and protein content were found in control and yoghurt containing 25% mango respectively.

4.1.3 Total solid and Ash

Addition of fruit had significant difference ($p<0.05$) on total solid and ash contents of yoghurt. Total solids content of fruit flavored yoghurt decreased with increases of fruit percentage because of lower fat and protein content in fruit. Similar observation was reported by Hossain *et al.,* (2012) who found that, the total solid content decreased with increasing fruit juice percentage. The result also indicated that, the highest (16.57%) total solid content of the yoghurt was obtained from the control sample. Whereas, the mean total solid contents of fruit flavored yoghurt (25% of mango and 25% of papaya) were nearly similar. The ash content of fruit flavored yoghurt was also decreased with increase of fruit juice percentage (concentration). The result was in accordance with the work of Debashis *et al.,* (2016) who found that, ash content in papaya and watermelon yogurts decreased with the increase of pulp concentration. This might be due to low content of ash in mango and papaya fruits as compared to row milk. The highest (0.67%) ash was found in plain yoghurt (control sample) and the lowest (0.63%) ash was found in fruit flavored yoghurt containing 25% mango.

Table 2 Mean of physico-chemical analysis of fruit flavored yoghurt

.	Physico-chemical properties					
Treatments	**Ph**	**T. acidity**	**Fat**	**Protein**	**T solid**	**ash**
C	$4.30±0.05^{a}$	$0.64± 0.01^{g}$	$4.05±0.05^{a}$	$3.69 ± 0.05^{a}$	$16.570±.05^{a}$	$0.67± 0.00^{a}$
M1	$4.25±0.05^{a}$	$0.74±0.01^{e}$	$3.95± 0.05^{a}$	$3.360±.02^{d}$	$16.08 ± 0.14^{b}$	$0.66±0.00^{ab}$
M2	$4.01± 0.01^{bc}$	$0.78 ±0.01^{c}$	$3.80±0.00^{b}$	$3.38± 0.00^{cd}$	$16.06 ± 0.07^{b}$	$0.65±0.01^{b}$
M3	$3.93±0.07^{cde}$	$0.81 ± 0.01^{b}$	$3.65± 0.05^{cd}$	$3.34±0.00^{de}$	$15.20± 0.05^{c}$	$0.63±0.00^{c}$
M4	$3.92\ 0±.06^{e}$	$0.85± 0.01^{a}$	$3.5± 00.00^{e}$	$3.29 ± 0.01^{f}$	$14.64± 0.06^{e}$	$0.63±0.00^{c}$
P1	$4.180\ ±03^{ab}$	$0.68 ± 0.01^{f}$	$3.80± 0.00^{bc}$	$3.54±0.035^{b}$	$16.05±0.00^{b}$	$0.67±0.00^{a}$
P2	$4.09\ ±0.01^{bc}$	$0.76 ±0.00^{d}$	$3.75± 0.05^{cd}$	$3.43±0.02^{c}$	$15.03±0.00^{cd}$	$0.66±0.00^{ab}$
P3	$4.06± 0.00^{bcd}$	$0.77± 0.01^{b}$	$3.55± 0.05^{cd}$	$3.39±0.00^{cd}$	$14.82±0.02^{de}$	$0.66±0.00^{ab}$
P4	$4.010±.005^{cde}$	$0.80 ± 0.01^{b}$	$3.55± 0.05^{ef}$	$3.30±0.00^{ef}$	$14.85±0.02^{de}$	$0.65±0.05^{b}$

All values are mean± SE and means with different superscripts within column are significantly different ($P < 0.05$).

C: control (plain yoghurt), M1= 10% Mango + 90% yoghurt, P1= 10%Papaya + 90 yoghurt, M2= 15% Mango + 85% yoghurt, P2= 15% Papaya + 85% yoghurt, M3, 20% mango + 80% yoghurt, P3= 20% of Mango + 80% yoghurt and Papaya, M4= 25% mango + 75% yoghurt, P4 =25% papaya + 75% yoghurt.

4.2 Microbial quality of fruit flavored yoghurt

The microbial quality of control and fruit flavored yoghurt samples are presented in table 3. Result showed that, lactic acid bacteria, total aerobic mesophilic bacteria, total coliform count, and yeast and mould count were significantly ($p<0.05$) affected by the type of fruit and their percentages used in yoghurt. Total mesophilic bacteria, total coliform and yeast and mould count were increased with increased of fruit juice percentage in fruit flavored yoghurt samples. This might be related to the increased level of fruits in yoghurt and microbial load from fruits used for flavored yoghurt preparation. Similar results were reported by Con, *et al., (*1996) who found that, increased yeast and mould counted when fruit flavor increased in yoghurt. Similarly, Tarakci and Kucukoner (2003) also stated that, Total aerobic mesophilic bacteria and yeast and mould counts in control sample was lower than yoghurt samples containing fruit juice. The results of this study indicates that, among fruit flavored yoghurt samples, the microbial quality of yoghurt containing 10% mango was least for total aerobic mesophilic bacteria (7.85 log cfu/ml), total coliform (4.24 log cfu/ml) and yeast and mould count(6.21 log cfu/ml). This might be related to the low percentage of mango that may have low microbial load as compare to those samples with more than 10% mango juice.

The result of the present study also indicates that, the highest (7.22 log cfu/ml) lactic acid bacteria count was obtained from the control sample. Whereas, the lowest (7.03 log cfu/ml) lactic acid bacteria was recorded from yoghurt sample containing 25% mango juices. Lactic acid bacteria count of fruit flavored yoghurt was decreased with increases of fruit juice percentage. The finding of this study agrees with report of Prescott *et al.*, (2005), which stated that, lactic acid bacteria grow optimally under slightly acidic condition when the pH is between 4.5 and 6.4. In addition to the pH value, concentration of lactose in fruit flavored yoghurt samples may also influence the growth of lactic acid bacteria.

Table 2.Microbial analysis results of fruit flavored yoghurt

Treatment	Microbial quality (log cfu/ml)			
	Total bacteria	**Total coliform**	**Yeast and mould**	**Lactic acid bacteria**
C	7.86±0.04^{b}	3.65±0.02^{e}	5.78±0.03^{c}	7.22 ±0.03^{a}
M1	7.85±0.04^{b}	4.24±01^{d}	6.21±0.04^{ab}	7.16±0.40^{b}
M2	7.89±0.01^{b}	4.63±0.02^{b}	6.27±0.00^{ab}	7.08 ± 0.00 ^{de}
M3	8.16±0.00^{a}	4.84±0.01^{a}	6.28±0.02^{ab}	7.05 ±0.01^{de}
M4	8.22±0.01^{a}	4.84±0.03^{a}	6.32±0.02^{a}	7.03 ±0.01^{e}
P1	8.17± 0.00^{a}	4.37±0.01^{c}	6.03±0.00^{b}	7.14 ±0.01^{bc}
P2	8.18±0.00^{a}	4.82± 0.09^{a}	6.18±0.01^{ab}	7.09±0.01^{cd}
P3	8.18±0.01^{a}	4.79±0.0.01^{a}	6.19±0.01^{ab}	7.06±0.01^{de}
P4	8.20±0.01^{a}	4.78±0.01^{a}	6.23±0.00^{ab}	7.03±0.01^{de}

All values are mean ±SE and means with different superscripts within column are significantly different ($P < 0.05$).

C: control (plain yoghurt), M1= 10% Mango + 90% yoghurt, P1= 10%Papaya + 90 yoghurt, M2= 15% Mango + 85% yoghurt, P2= 15% Papaya + 85% yoghurt, M3, 20% mango + 80% yoghurt, P3= 20% of Mango + 80% yoghurt and Papaya, M4= 25% mango + 75% yoghurt, P4 =25% papaya + 75% yoghurt.

4.3 Sensory Evaluation of flavored yoghurt

Table 3: Effect of fruit juice type and concentration on sensorial acceptability of Fruit flavored yoghurt.

Sensory attributes	Different type of fruit flavored yoghurt															
	10% fruit flavored yoghurt				**15% fruit flavored yoghurt**				**20%fruit favored yogurt**				**25% fruit flavored yoghurt**			
	C	**M1**	**P1**	**LS**	**C**	**M2**	**P2**	**LS**	**C**	**M3**	**P3**	**LS**	**C**	**M4**	**P4**	**LS**
Color	38.7	53.2	20.4	**	38.7	68.6	46.0	**	38.7	65.5	32.0	**	38.7	53.1	31.9	*
Odor	18.4	55.8	43.5	***	18.4	76.5	46.2	***	18.4	56.4	41.8	***	18.4	37.6	33.3	*
Sourness	37.0	47.2	39.6	NS	37.0	60.3	52.1	*	37.0	57.4	47.8	*	37.0	19	49.2	*
Taste	25.1	44.8	30.9	**	25.1	69.4	35.2	***	25.1	72.2	43.4	**	25.1	44.8	32.4	**
Flavor	27.6	42.5	29.9	*	27.6	77.7	34.4	***	27.6	61.1	45.5	**	27.6	42.5	34.5	**
Overall acceptability	20.2	51.9	44.8	**	20.2	78.3	39.3	***	20.2	58.1	36.9	***	20.2	44.8	45.2	*

C: control (plain yoghurt), M1= 10% Mango + 90% yoghurt, P1= 10%Papaya + 90 yoghurt, M2= 15% Mango + 85% yoghurt, P2= 15% Papaya + 85% yoghurt, M3, 20% mango + 80% yoghurt, P3= 20% of Mango + 80% yoghurt and Papaya, M4= 25% mango +75% yoghurt, P4 =25% papaya +75% yoghurt, LS:Level of significance, * Significant at 5% level, ** Significant at 1% level, *** Significant at 0.1% level, NS: Not Significant.

A 10% of fruit juice yoghurt: The statistical analysis showed that, there was significant difference (P<0.01) for the case of color and taste between 10% of fruit juice yoghurt and the control. The rank of plain yoghurt (C), M1 and P1 also were 38.7, 53.2 and 20.4 respectively. The highest rank of taste was recorded for the M_1; however, the lowest rank of taste was seen for the plain yoghurt. Similar work was reported by Duangrutai (2014) who found that, the ranks of pineapple yogurt and mango yogurt were higher than papaya flavored yogurt and yogurt without fruit. The result obtained in this study indicates that, the highest and lowest rank of flavor was observed in M1 yoghurt and plain yoghurt (control) respectively. Related result was reported by Amal *et al*., (2016) the yoghurt containing papaya pulp had the higher mean scores (appearance and color, flavor, body and texture and overall acceptability) as compared to plain yogurt. The result is more or less similar to other researcher (Madhu *et al*., 2012). However, there was no significance difference on the sourness between the plain yoghurt and fruit flavored ones; M1 yoghurt and P1 yoghurt respectively.
A 15% of fruit juice yoghurt: There was significance difference between sensory attributes across yoghurt incorporated with M2, P2 and plain yoghurt. Fruit flavored yoghurt (M2) which was incorporated with 85% plain yoghurt had significant difference (P<0.001) in the case of sensory attributes such as odor, taste, flavor and overall acceptability. A 15% of fruit flavored yoghurt (M_2) scored highest rank of color (68.6), odor (76.5), taste (69.4), sourness (60.3), flavor (77.7) and overall acceptability (78.3). Although, 15% papaya fruit juice yoghurt (P_2) was not preferred by panelist over mango fruit juice yoghurt (M2), higher rank was recorded for all sensory attributes as compared to plain yoghurt. The result agrees with the work of Debashis *et al*., (2016), who found that, yoghurt with 15% of papaya is mostly acceptable and recommendable for large scale of fruit yoghurt. In addition to that, similar report was reported by Abdallah and Mohamed (2017) who stated that, mangoes are more suitable to use as flavoring material in yoghurt manufacture. The result also indicates that, all sensory attributes (color, flavor, taste, sourness and overall acceptability) becomes optimal when 15% mango juice is added, which gave highest rank. The same is true for 15% of papaya juice which resulted in acceptable level of improvement for sensory attributes and nutritional quality.
Yoghurt with 20% fruit juice: Rank score of color, odor, flavor and overall acceptability of both M3 and P3 were decreased as compared M2 and P2. Statistical analysis shows that there was statistically significant difference (P <0.01) between plain and fruit flavored yoghurt in case of color, taste and flavor. Highest taste score (72.2) record was seen in case of 20% of fruit flavored yoghurt (M3). However, the rank scores of color, flavor, odor and overall acceptability (M3 and P3) for fruit flavored yoghurt were decreased as compared to 15% of fruit flavored yoghurt (M2 and P2). The result obtained is similar with the work of Dessie *et al., (*1994) who reported that, the addition of fruit juice improved the color and texture of yoghurt. The results of the present study indicate that, addition of fruit juice with appropriate concentration level has improved sensory attributes of yoghurt. On the other hand, except for color, lowest ranks of sensory attributes (odor, sourness, taste, flavor and overall acceptability) were seen in case of plain yoghurt. Dessie *et al*., (1994) reported similar results which showed, the smell and taste scores of mango and pineapple flavored yoghurt were higher than that of the control yoghurt. The taste of fruit juice yoghurt (M3) scored highest rank as compared to the fruit juice yoghurt (P3) and plain yoghurt. This might be attributed to more carbohydrate content of mango as compared to papaya and plain yoghurt.
Yogurt with 25% fruit juice: Significant differences (P< 0.05) were observed in color, odor, sourness and overall acceptability of fruit juice yoghurt as compared to the plain yoghurt (Table 3).The highest rank score was found for fruit flavored yoghurt (M4) in terms of color (53.1), odor (37.6), flavor (42.5) and overall acceptability (44.8) while the lowest rank for color (31.9), odor (18.4), sourness (19), taste (25.1) and flavor (27.6) were seen in case of fruit flavored yoghurt of papaya (P4), plain yoghurt (C), fruit juice yoghurt of mango (M4) and plain yoghurt (C) respectively. The highest rank of taste (44.8) and flavor (42.5) were seen for the flavored yoghurt (M4) while the lowest rank of taste and flavor were seen for plain yoghurt. Taste and odor interaction is a consequence for the flavor of fruit based yoghurt. Hence, highest rank of taste of fruit flavored mango, improve the flavor of fruit flavored yoghurt.

5. Conclusion

Addition of the mango and papaya juice to yoghurt with optimal level improved sensory attributes and physico-chemical properties of yoghurt. Among fruit flavored yoghurt ones, 15% mango flavored yoghurt scored highest rank as compared to others fruit flavored yoghurt and plain yoghurt. The product developed can contribute for food and nutrition security in the country by increasing fruit and animal product consumption.

6. References

Alan Hugunin, 1999. Whey products in Yoghurt and Fermented Dairy Products, Applications monograph: Yoghurt, Published by U.S. Dairy Export Council, Pleasanton. California, USA
Amal, A. Matter, Eman, A. M. Mahmoud, Nahla S. Zidan, 2016. Fruit Flavored Yoghurt: Chemical, Functional and Rheological Properties. International Journal of Environmental & Agriculture Research. Vol-2, Issue-5,

2016.
AOAC - Association of Official Analytical Chemistry, 2005. Official methods of analysis of international, 17 ed., Vol .all. Washington DC, USA.
Bodyfelt FW, Tobias J, Trout GM 1988. The Sensory Evaluation of Dairy Products. New York,NY, USA: Van Nostrand Reinhold.
Con, A. H., Cakmakc S., Caglar A. and Gokalp H. Y. 1996. Effects of different fruits and storage periods on microbiological qualities of fruit-flavoured yogurt produced in Turkey. *J. Food Prot*., 59: 402-406.
Chandan, R.C., and Shahani K.M., 1993. Yogurt. In: *Dairy Science and Technology Handbook: Product Manufacturing, Vol. 2*, Y.H. Hui (Ed). New York: Wiley-VCH. pp.1-56.
Bardale, P.S., Waghmare, P.S., Zanjad, P.N., and Khedkar, D.M., 1986. The preparation of shrikhand like product rom skin chakka by fortifying with fruit pulps, *Indian* J. 38,431-432.
Duangrutai Thumrongchote, 2014. Effect of Thai fruits on Sensory properties of Fruit Yogurt and Survival of Yogurt Starter Culture added with Probiotic Strains in Fruit Yogurt. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 5(3) P.287.
Desai, S.R., V.A. Toro and S.V. Joshi, 1994. Utilization of different fruit in the manufacture of Yoghurt. Indian J. Dairy Sci., 47:870-874.
Debashis Kumar Dutta Roy, Tanny Saha, Moriom Akter, Mojaffor Hosain, Habiba Khatun, Manik Chandra Roy.2015. Quality Evaluation of Yogurt Supplemented with Fruit Pulp (Banana, Papaya, and Water Melon). *International Journal of Nutrition and Food Sciences.*Vol. 4, pp. 695-699. doi: 10.11648/j.ijnfs.20150406.
FAO (Food and Agricultural Organization of the United Nations), 1997. Microbiology Analysis. Manual of Food Quality Control. FAO Food and Nutrition Paper 14/4 Rev. 1.
H. Michael W. and Joseph F. Frank 2004. Standard Methods for the Analysis of Dairy Products. 17th edition, American Public Health Association, Washington, D.C., USA.
Hossain M. N., Fakruddin M. and Islam M. N. 2012. Quality comparison and acceptability of yoghurt with different fruit pulps. *J Food Process Technol*, 3 (8): 171.
IDF.1988. Yogurt: Enumeration of characteristics organism-colony count techniques at 37^{o}C. Standard No.117A.Brussels. International Dairy Federation.
Madhu, M.Shiva Prakash, Anita Koc hhar,Neetu, 2012. An investigation of sensory evaluation of flavored yoghurt made with different starter culture during storage. International Journal of food Science and Nutrition Science. Vol.01, www. ijfans.com.
Mohammad Abdalla Musa Salih and Mohammad Osman Mohammad Abdalla, 2017. Physico chemical and sensory characteristics of stirred yoghurt flavored with mango (mangifera indica L.) fruit during storage period. Pak.J.Nutr. 16:378-383
Tarakci Z. and Kucukoner E. 2003. Physical, Chemical, Microbiological and Sensory Characteristics of Some Fruit- Flavored Yoghurt. *YYÜ Vet Fak Derg*, 14 (2): 10-14.
Routray W and Mishra HN, Scientific and technical aspects of yoghurt aroma and taste: Comprehen Rev Food Sci Food Safety, 10(4) (2011) 208-220.
O'Connor C.B. 1994. Rural Dairy Technology. ILRI Training Manual 1.1995. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia Pp. 133.
Prescott, L. M., Harley, J. P. and Klein, O. A. 2005. Microbial nutrition, types of media, in: Microbiology, 6th Ed. Mc Graw Hill Publisher, New York. pp. 95 – 105.
Punnagaiarasi, A., Rajarajan, G. and Elango, A 2016. Assessing the organoleptic quality of stirred papaya yoghurt during storage period. International Journal of Science and Nature. I.J.S.N., VOL.7 (4) 2016: 878-880.
Sanchez Segarra P J M, Gracia Martine Z, Gordillo-Oetero M J, Diozvalverde A, Amaro Lopez M A and Morneo-Rojas R. 2000. Influence of the addition of fruits of the mineral content of yoghurt nutritional assessment, *Food. Chm* , 85-89.
Starleya, I. F., Paul M., Geisela S. and Stephen W. B. 1999. The treatment of pediatric burns using topical papaya. *Burns*, 25: 636-639.
Willey TM, Sherwood LM, Woolverton, Perscott Harley and Klein Microbiology 2008. 7th edition MC-Graw Hill, New York P. 1038