



Evaluation of yoghurt from fresh cow milk fortified with mango (*Mangifera indica* L.) pulp in Northern Nigeria

N.P. Achi^{*1}, J.N. Achi², I. Mallam³

¹Dairy Research Programme, National Animal Production Research Institute/Ahmadu Bello University, Shika, Zaria

²Department of Agricultural Education, School of Vocational Studies, Nuhu Bamali Polytechnic, Zaria

³Department of Animal Science, Kaduna State University, Kafanchan Campus

(Manuscript received 22 June 2024; accepted for publication 31 July 2024)

Abstract. This study was conducted to evaluate the physicochemical properties, antioxidant content and the sensory attributes of fresh cow milk yoghurt fortified with mango pulp. Yoghurt samples were prepared from different proportions of yoghurt and mango pulp as follows: 100:0 (Control), 90:10 (10% MPY), 86:14 (14% MPY), 82:18 (18% MPY), 78: 22 (22% MPY) with sugar level maintained at 5 % (by weight) and was evaluated for physicochemical, antioxidant content and the sensory attributes of yoghurt from fresh cow milk fortified with mango pulp (MPY). The data collected for physicochemical, antioxidant content and the sensory attributes of the yoghurt were analyzed using the Statistical Package for Social Sciences (SPSS, 2016) version 16.0. The result for proximate composition of the yoghurt samples showed significant increase in total solids, ash and titratable acidity and was reported highest in 22% MPY while the pH, protein and fat content decreased with the increase in mango pulp concentration across the treatment combinations. The antioxidant capacity measured in the study was vitamin C, phenols and tannins. The vitamin C content significantly increased with addition of mango pulp recorded highest in 22% MPY ((4.97) while phenols and tannins decreased with increase in mango pulp concentration and reported highest in control yoghurt. The organoleptic results revealed more consumer acceptance for control yoghurt over the other treatments combinations and found higher in all the sensory parameters; aroma, appearance, texture and general acceptability except for the taste which reported highest in 14% MPY (3.80) and lowest in 10% MPY (2.80). In the case of physicochemical composition of the yoghurt samples, fat and protein content decreased with increase in mango pulp concentration to the yoghurt while the total solids, ash and titratable acidity increased. For enhancement of minerals, vitamins and antioxidant capacity of yoghurt drink, acceptable quality can be produced by blending yoghurt with 22% mango pulp combination there by promoting the health benefit of consumers.

Keywords: Fortification, yoghurt, mango pulp, physicochemical, antioxidant, sensory

Introduction

Mango (*Mangifera indica* L.) is one of the most cultivated fruit in the tropical and subtropical

regions. Mango is native to South Asia, wherefrom it has spread worldwide to become one of the most extensively exploited fruits (Hoque et al., 2018). In 2017, world mango production was about 50.65

*e-mail: neyuachi@gmail.com

million metric tons (FAOSTATS, 2019), occupying an area of over 4.37 million hectares. Various parts of mango such as fruit (pulp, peel, and stone), leaves, and bark are rich sources of fiber and bioactive compounds (Rymbai et al., 2013; Monribot-Villanueva et al., 2019). The fruits are specifically rich in antioxidants known to reduce the risk of cardiac disease with the potential of anticancer and antiviral activities (Jash and Brahmachari, 2015).

Milk is a translucent white liquid produced by the mammary glands of mammals (William and Bowen, 2005). The females of all mammal species can by definition produce milk, but cow's milk dominates commercial production. In 2011, FAO estimates that 85% of all milk worldwide was produced from cows. Milk and milk products are excellent high quality foods, providing nutrients (Aboul et al., 2005). Yoghurt is regarded as a nutritious dairy food product that helps improve the health of humans. Yoghurt entails several nutrients because of the process of fermentation and manufacturing processes. It contains many micronutrients such as riboflavin, vitamins, calcium, zinc, potassium, and magnesium. The quantities are higher than other dairy products, even from the product yoghurt is made, i.e., milk (Tremblay and Panahi, 2017). Foods that contain high quantity of antioxidants are very important in the prevention of chronic diseases such as cardiovascular diseases and cancer (Ames et al., 1993).

Yoghurt fortification by addition of fruit juices is forming a new trend in Nigeria. Fruits like mango are available abundantly in Nigeria particularly during its season, and are found at cheaper price compared to other table fruits such as apple, pineapple, orange, etc. However, the literature points out that dairy food products have a limited content of bioactive compounds, which can remove some value from these products. Therefore, to overcome this limitation incorporation of plant or fruit based additives to fortify the yoghurt is necessary. Since yoghurt is highly appreciated and is important in human diet, it is produced and consumed massively in many countries including Nigeria (Serafeimidou et al., 2013; Shori and Baba, 2014). Therefore, supplementation of yoghurt with fruits like mango presents a new option to add further

value to the yoghurt by producing a variety of tastes and increasing the level of natural antioxidants for the improvement of human health. Hence, yoghurt fortification will benefit society both in health and improvement of consumers' appeal. Therefore, the broad objective of this study was to evaluate the physicochemical properties, antioxidant content and evaluate the sensory attributes of fresh cow milk yoghurt fortified with mango pulp.

Material and methods

Experimental site

The study was conducted at the Dairy Research Programme, National Animal Production Research Institute (NAPRI) and Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria located between latitude 11° 12' N, 07° 33' E and 640m altitude above the sea level. The area is within the Northern Guinea Savanna of Nigeria with an average rainfall of 1102mm to 1904mm per annum which lasts from late April or early May to October and varying temperature of 31°C maximum during the dry season and 18°C minimum during the wet season. The mean relative humidity during harmattan period is 21% and during wet season it is 72% (IAR, 2021).

Materials and sources

The ingredients and materials used for the study include: Fresh cow milk, starter culture, sugar, 100ml storage bottles, fresh ripened mango fruits. The fresh mango fruits were purchased from local fruit market Kwangila, Zaria. Ten (10) litres of fresh cow milk was obtained from Dairy Farm of National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Zaria.

Experimental design

The experiment was laid out in completely randomized design (CRD) with 5 treatments and 4 replicates in each treatment. Yoghurt drink was prepared by using four levels of mango pulp and one control treatment (without the fruit pulp).

The details of the treatments were as follows:

T0 = 0% mango pulp + 100% of yoghurt;

T1 = 10% mango pulp + 90% of yoghurt;
 T2 = 14% mango pulp + 86% of yoghurt;
 T3 = 18% mango pulp + 82% of yoghurt;
 T4 = 22% mango pulp + 78% of yoghurt.

Apparatus

The apparatus used include; Weighing balance, Furnace, Oven, Porcelain crucible, Sintered crucible, Spatula, Volumetric flask (100ml), Measuring cylinder, Beakers, Conical flask, Desiccators, Macro kjeldahl digestion apparatus, Micro steam distillation apparatus, Pipettes (10ml, graduated), Burettes (50ml), Porcelain tile, Glass rod, UV/Visible Spectrophotometer, Hot plate, Filter paper, Funnel

Yoghurt preparation

The fresh cow milk was measured to ensure that it is up to the volume required for the research. The milk was then filtered to remove any foreign materials or dirt present, using a cleaned cloth sieve. Pasteurization process was carried out using high temperature at 85°C for 30 minutes, aiming to control pathogenic bacteria. Thus, the culture could grow optimally. During the pasteurization process, stirring was done to avoid coagulation of the milk, which causes the mixture to become homogeneous. Pasteurized milk was cooled rapidly to 42°C which is the ideal temperature for starter culture and also to control the heat loving pathogenic bacteria. The starter culture containing *Lactobacillus bulgaricus* and *Streptococcus thermophilus* was inoculated in a ratio of 1:1 and vigorously mixed. The mixture was left to incubate for 7 to 8 hours. After the incubation period, the yoghurt was set. Sugar at 5% by weight of the product was added and uniformly stirred.

Preparation of mango pulp

Uniformly ripened mangoes of Temo variety popularly known as Apple mango were purchased from Kwangila fruits market Kwangila, Zaria, Kaduna State, Nigeria. The gross weight of the fruits were determined to be four kilograms (4 kg), the fruits were washed, peeled, de-stoned and subjected to slicing. The sliced fruits were then macerated in an electric blender for easy blending

and homogenization. The pulp was then pasteurized in a water bath at a temperature of 82±2°C for 30 minutes to reduce the microbial load and stored in a container kept in a refrigerator prior to further usage. The calculated amount of mango pulp as per treatment combination was done. The mixture was uniformly mixed with stirrer and packed in sterilized 100ml storage bottles and stored at 5° C in refrigerator.

Proximate Analysis

Crude protein content

5ml of each of the samples was placed into different digestion tubes, 5 g of catalyst (mixture of Na₂SO₄ and CuSO₄ in ratio 5:1) was added to each of the flasks followed by the addition of 25 cm³ Concentrated H₂SO₄. The digestion tubes containing the mixtures were placed on digestion apparatus and heat was supplied below the boiling point of the acid until frothing ceased. The mixtures were allowed to boil vigorously until there was complete oxidation or until the mixtures became clear. The digests were allowed to cool and diluted with distilled water to avoid caking down of the digest. The digests were made up to a known volume in different volumetric flasks with distilled water, the flasks were properly labeled. An aliquot from the digest was placed in the distillation apparatus and 20 cm³ of NaOH solution (40%) was added. The mixture was heated up as a result of the heat generated from the boiling water in the tank. The liberated ammonia was collected in boric acid containing few drops of methyl red indicator which changed to yellow color when ammonia came in contact with it. The distillation was continued until twice the initial volume of the boric acid was collected. The distillation was discontinued, the distillate collected was titrated against standard hydrochloric acid solution (0.02M) and the corresponding titer values were recorded.

Calculation

Total nitrogen, per cent by weight (on moisture – free basis)

% Nitrogen = 14.01 × molarities × extraction vol. × titer value × 100

Aliquots × 1000 × sample weight

Where:

14.01 = Relative molecular weight;

Molarity = concentration HCL solution [0.0183M];

Extraction volume = the total volume of the digest [100cm³];

Titer Value = the total volume of acid used on titration;

Aliquot = the volume of digest that was distilled [10cm³];

Sample weight = the weight in gram of the material used;

100 = percentage conversion factor.

% Crude Protein = % Nitrogen × 6.38

Where:

6.38 = Nitrogen conversion factor.

Determination of fat content

10ml of 90% H₂SO₄ was placed into different butyrometers, 11ml each of the yoghurt samples was added to acid in the butyrometers. 1ml of n-amyl alcohol was equally added to each of the samples in the butyrometer, the butyrometers were corked and mixed thoroughly by inverting the butyrometers several times until the mixture mixed well. The butyrometers containing the mixtures were centrifuged at 3000rpm for fat separation. The butyrometers were placed in a water bath containing very hot water for proper separation of the fat, and the separated fat was read from the graduated part of the butyrometers.

Determination of ash content

The residue that was obtained from the total solid analysis was used for this analysis.

The crucibles containing the residues were ashed in the furnace at 550° – 600°C for 3 hours; the crucibles containing the ash residue were cooled in a desiccator and weighed.

Calculation

$$\% \text{ Ash} = \frac{W_2 - W_1}{W} \times 100$$

W₁ = the weight in grams of empty crucible

W₂ = the weight in grams of crucible + ash

W = the weight in grams of the sample

Physicochemical Analysis

Determination of pH content

The pH of the yoghurt samples (5ml) was measured electrometrically using a standard pH meter according to AOAC method. The instrument was standardized using buffer solutions of pH 4.0 and 9.0. The pH electrode was dipped into yoghurt and after a few minutes of equilibration, the pH of the samples was measured.

Determination of titratable acidity

Titrateable acidity was determined using the method of AOAC. The sample (5 ml) at 25°C was measured into a flask and diluted to twice its volume with distilled water. Phenolphthalein indicator (2 ml) was added to each yoghurt sample and titrated with 0.1 M NaOH to the first permanent pink color. The acidity was reported as the percentage Lactic acid by weight as shown in the following equation:

$$\text{Titrateable acidity (\%)} = \frac{\text{quantity of the yoghurt sample} \times 0.009 \times 100}{\text{Quantity of NaOH (ml)}}$$

Determination of total solids content

Total solids of the samples were determined in accordance with the method described by AOAC. 5 ml of each of the samples was placed into different crucibles that had already been weighed. The crucibles containing the samples were dried in an oven for 24hrs at 105°C, cooled in desiccators and weighed.

Calculation

$$\% \text{ Total Solid} = \frac{W_2 - W_1}{W} \times 100$$

W₁ = the weight in gram of empty crucible

W₂ = the weight in gram of crucible + residue

Antioxidant Activity Test

Determination of phenol content

10cm³ of the milk sample was placed in a beaker; 10ml of distilled water was added. The mixture was heated up on a hot plate for 5minutes. The mixture was filtered into 50cm³ volumetric flask with the help of filter paper; filtrate was made up to the mark with distilled water. This filtrate was then reserved for phenol analysis.

Preparation of phenols standard

0.1g of gallic acid was accurately weighed into a beaker, small quantity of water was added, and the mixture was stirred until homogeneous solution was obtained. The solution was transferred into a 100ml volumetric flask and made up to the mark with distilled water; this gave 1000ppm of gallic acid stock solution.

Preparation of intermediate standard (50 ppm)

5cm³ of the stock standard of gallic acid was placed in 1000cm³ volumetric flask and made up to the mark with distilled water to obtain 50ppm of gallic acid intermediate standard.

Preparation of working standard

5ml of folincalteous reagent was placed into five different 50ml volumetric flasks. 0.20 ml, 0.40 ml, 0.60 ml, 0.80 ml and 1.0 ml of gallic acid were added to these volumetric flasks, followed by the addition of 5ml 17% Na₂CO₃ solution and the solutions in the flasks were made up to the mark with distilled water. The concentration gave 0.20 ppm, 0.40 ppm, 0.60 ppm, 0.80 ppm and 1.0 ppm, respectively, of the gallic acid working standard.

The unknown (samples) were prepared in the same manner by placing 5 ml of the prepared sample milk in 50 ml volumetric flasks, 5 ml of the folincalteous reagent was added followed by the addition of 5 ml 17% Na₂CO₃ solution and made to the mark with distilled water. The mixture was allowed to stand for 30 minutes for proper color development. The absorbance was taken at 670

nm. The blank sample was equally determined.

Determination of Tannins Content

Preparation of tannin standard (1000 ppm)

0.1g of tannic acid was placed in a beaker, little quantity of distilled water was added to the content in the beaker, and the mixture was stirred until it dissolved completely. The solution was transferred quantitatively into a 100ml volumetric flask and made up to the mark with distilled water.

Preparation of intermediate standard (50 ppm)

5ml of the tannin stock standard solution (1000 ppm) was placed in a 100 ml volumetric flask and made up to the mark with distilled water to give 50 ppm of tannin intermediate standard.

Preparation of working standard

5 ml of folincalteous reagent was placed in five different 50 ml volumetric flasks. 0.20 ml, 0.40 ml, 0.60 ml, 0.80 ml and 1.0 ml of tannic acid intermediate standard were added to these volumetric flasks, followed by the addition of 5ml 17% Na₂CO₃ solution and the solutions in the flasks were made up to the mark with distilled water. The concentration gave 0.20 ppm, 0.40 ppm, 0.60 ppm, 0.80 ppm and 1.0 ppm, respectively, of the tannic acid working standard.

The unknown (samples) were prepared in the same manner by placing 5 ml of the milk extract in 50ml volumetric flasks, 5ml of the folincalteous reagent was added followed by the addition of 5ml 17% Na₂CO₃ solution and made to the mark with distilled water. The mixture was allowed to stand for 30 minutes for proper color development. The absorbance was taken at 550nm. The blank sample was equally determined.

Preparation of ascorbic acid standard

0.250g vitamin C (ascorbic acid) was placed in a beaker and little distilled water was added, the mixture was allowed to dissolve and transferred quantitatively into a 250 cm³ volumetric flask, the

solution was made to the mark with distilled water. The flask was labeled as vitamin C standard.

Preparation of starch indicator solution (1%)

0.50g of soluble starch was dissolved in small quantity of water in a beaker, nearly boiled hot distilled water was added to 50ml marked stirred properly and labeled starch indicator.

Preparation of Iodine Solution

5.0g of potassium iodide and 0.268g of potassium iodate were placed in a clean beaker, small quantity of distilled water was added, and the mixture was stirred until it dissolved. The solution was transferred into 500ml volumetric flask, 30ml of 3 M sulphuric acid was added to the solution in the volumetric flask, the solution was made up to the mark with distilled water, and labeled as iodine solution.

Standardization of solution

25cm³ of vitamin C standard solution was placed in a conical flask (125 ml capacity). 10 drops of starch indicator was added. The burette was rinsed with a small volume of iodine solution and the burette was filled with iodine solution above the mark which was later brought to the meniscus. The solution was titrated until the endpoint was reached, this happened when the blue color appeared which persisted for 20 seconds and the titer value was recorded. The titration was repeated twice.

Titration of the yoghurt samples

25ml of yoghurt sample was placed in 125ml conical flask, 10 drops of starch indicator was added. The solution was titrated against iodine solution until the appearance of blue color that persisted for 20 seconds. The titration was repeated twice and the titer values were recorded.

Sensory Evaluation

Twenty (20) member panel of sensory judges consisting of semi-trained students from Samaru College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, familiar

with quality attributes of yoghurt was constituted. Analysis of the results was carried out by sensory tests, which include appearance, taste, aroma, texture, and general acceptability. The panelists rated according to a hedonic scale (1= dislike very much, 2= moderately dislike, 3= neither like nor dislike, 4= moderately like, 5= very much like).

Data Analysis

The data on physicochemical properties, antioxidant content and evaluation of the sensory attributes of fresh cow milk yoghurt obtained were statistically analyzed using SPSS (2016) version 16.0. The data were evaluated by ANOVA, and Duncan's Multiple Range Test was conducted to compare means. Differences were considered to be significant at $P < 0.05$; 0.01 .

Results and discussion

Physicochemical composition of yoghurt from fresh cow milk fortified with mango pulp is presented in Table 1. The results showed significant ($P < 0.01$) effect except on fat and protein. The total solids and ash had significantly ($P < 0.01$) higher values in 22% MPY (41.62 and 0.39).

However, the control had significant ($P < 0.01$) pH (4.67) and the least value (3.06) was found in 22%MPY while the highest Titratable acidity (1.15) was observed in 22% MPY.

This is in agreement with the report of Ronak et al. (2016) who stated that the total solids contents in the mango pulp are higher than that of milk. Generally, the percentage of total solids increase with increase of mango pulp concentration. The increase in acidity was there as mango pulp contains more acidity than the milk. The results for acidity content were similar to those obtained by Khan et al. (2008). The pH values of all mango pulp yoghurt treatments were lower than that of the control (4.67), addition of mango pulp decreased significantly ($p < 0.01$) the pH values of yoghurt as a result of low pH of mango. Tanwar et al. (2014) reported similar results. The lowest pH in this study is in agreement with Ziena and Abd-Elhamid (2009). They reported that the decrement

in the pH values of functional yoghurt reflected the high activity of starter. There was no significant difference ($p>0.01$) in the values of protein across the treatments. The decrease in protein was due to addition of a varied proportion of mango pulp in yoghurt drink and since the protein content of the mango pulp is less than in milk and was in agreement with the results of Raut et al. (2015). There was no difference in percentage ash, which was similar and in agreement with the results of Kebary et al. (2015) and Kebary et al. (2018) stating that decrease in protein can be due to addition of a varied proportion of mango pulp in yoghurt drink.

The result is that fat content decreases as pulp increases and is in consonant with the reports by Desai et al. (1994) and Hossain et al. (2012) who reported that fruit contains low level of fat and that the addition of fruit juice might have decreased the fat content of fruit yoghurt.

Antioxidant content of yoghurt from fresh cow milk fortified with mango pulp is showed in Table 2: The results obtained showed significant ($P<0.01$) differences in all the parameters. The significantly ($P<0.01$) highest value (4.97) for Vitamin C was found in 22% MPY followed by 18% MPY and the least value (1.08) was found in control while the highest significant ($P<0.01$) tannin value (0.83) was observed in control followed by 10% MPY and the least tannin was found in 22% MPY but statistically similar with 18% MPY.

Fruit pulps contain various antioxidant compounds which act against oxidizing agents

(Jin et al., 2018). Adding fruit pulps to the yoghurt increased significantly ($p<0.01$) the RSA% and subsequently the antioxidant capacity of the yoghurt across the treatments. The highest value obtained for vitamin C was recorded in the yoghurt containing 22% of mango pulp (4.97) while the lowest result was found in the control yoghurt treatment (1.08). Vitamin C, therefore, showed significant difference ($p<0.01$) across all the treatment combinations. This is because mango pulp contains more vitamin C than the yoghurt.

The observed results are similar with the finding of Atwaa et al. (2020) on physicochemical, microbiological and sensory properties of low-fat probiotic yoghurt fortified with mango pulp fiber waste as source of dietary fiber.

Control group in this study had higher phenol which is contrary to the report of Ning et al. (2021) who observed that the addition of 2.5% passion fruit juice significantly increased the total phenolic content, radical 2, 2-diphenyl-1-picryl-hydrazyl (DPPH) radical scavenging rate and hydroxyl radical scavenging rate of set yogurt. This finding was attributed to the abundant polyphenols and high antioxidation activities of passion fruit juice, which could reach as high as 11.4 μg of gallic acid equivalent/g, 35.8% and 72.7%, respectively. Similarly, Jaster et al. (2018) found that the addition of concentrated strawberry pulp significantly increased total phenolic content and DPPH radical scavenging rate of set yogurt.

Table 1. Physicochemical composition of yoghurt from fresh cow milk fortified with mango pulp

	Concentrations of Mango pulp in the yoghurt					SEM	P- value
	Control	10% MPY	14% MPY	18% MPY	22% MPY		
Total solid	11.36 ^d	12.66 ^c	12.66 ^c	14.38 ^a	14.62 ^a	0.152	<0.01
Ash	0.28 ^c	0.28 ^c	0.28 ^c	0.35 ^b	0.39 ^a	0.018	<0.01
Fat	2.86	2.41	2.41	2.29	2.19	0.943	0.091
Protein	2.20	2.12	2.12	1.84	1.84	0.241	0.408
pH	4.67 ^a	4.43 ^b	4.43 ^b	3.39 ^d	3.06 ^e	0.075	<0.01
Titrateable acidity	0.57 ^e	0.69 ^d	0.69 ^d	1.02 ^b	1.15 ^a	0.037	<0.01

abcde means with different superscripts differ significantly across the row ($p<0.01$), MPY= Mango Pulp Yoghurt

Table 2. Antioxidant content of yoghurt from fresh cow milk fortified with mango pulp

Antioxidants	Concentration of Mango Pulp in the Yoghurt					SEM	P-value
	Control	10% MPY	14% MPY	18% MPY	22% MPY		
Vitamin C	1.08 ^d	1.62 ^{cd}	2.25 ^c	3.77 ^b	4.97 ^a	0.329	<0.01
Phenols	0.080 ^a	0.053 ^b	0.043 ^{bc}	0.025 ^{cd}	0.018 ^d	0.008	<0.01
Tannins	0.83 ^a	0.543 ^b	0.393 ^{bc}	0.283 ^c	0.235 ^c	0.059	<0.01

^{abcd} means with different superscripts differ significantly across the rows ($p < 0.01$), MPY= means mango pulp yoghurt

Table 3 showed the sensory evaluation of yoghurt from fresh cow milk fortified with mango pulp. The results showed no significant ($P > 0.05$) difference except in appearance. The control had highly significantly ($P < 0.01$) the highest value (4.30) followed by 18%MPY but similar with 22%MPY and the least was found in 10%MPY. Yoghurt sample blended with 14% mango pulp scored the highest score (3.80) for taste, whereas the lowest score was found in 10%MPY (2.80). The score recorded for aroma ranged from 3.15 to 3.70. The scores of organoleptic evaluation for overall acceptability recorded highest in the control sample (4.05) over the other treatment combinations though not statistically different. It was observed that the score for all the parameters did not follow a particular trend and was usually found higher in the control sample than in the other treatment combinations. This may be attributed to

the fact that the panelists were not well familiar with mango pulp yoghurt drink and it was probably their first time consuming that type of yoghurt.

The results in this study for sensory evaluation were similar with the report of Ning et al. (2021) who reported that passion fruit juice addition of 7.5% did not significantly change the color, appearance, body, or texture of set yogurt, whereas these indicators were substantially worsened with the addition of 10% passion fruit juice. But results of this study are contrary in terms of aroma, flavor, and general acceptability which stated that an increasing trend was observed with the addition of passion fruit juice, and these characteristics were greatly superior to the control when passion fruit juice additions were greater than or equal to 5%. Overall, in terms of consumer acceptability, the optimum addition level of passion fruit juice for set yogurt was 5 to 7.5% (Ning et al., 2021).

Table 3. Sensory evaluation of yoghurt from fresh cow milk fortified with mango pulp

	Concentration of Mango Pulp In the Yoghurt					SEM	P- value
	Control	10% MPY	14% MPY	18% MPY	22% MPY		
Appearance	4.30 ^a	2.65 ^b	3.35 ^{ab}	3.15 ^{ab}	3.15 ^{ab}	0.413	<0.01
Taste	3.25	2.80	3.80	3.00	3.50	0.372	0.067
Aroma	3.70	3.15	3.35	3.45	3.55	0.374	0.654
Texture	3.70	3.10	3.45	3.15	3.25	0.394	0.538
General acceptability	4.05	2.95	3.55	3.35	3.40	0.364	0.057

^{ab} means with different superscripts differ significantly across the row ($p < 0.01$)

MPY= Mango Pulp Yoghurt

Conclusion

From the organoleptic evaluation, the consumer preference for control yoghurt was more compared to mango pulp yoghurt drinks. In the case of physicochemical composition of the yoghurt samples, fat and protein content decreased with increase in mango pulp concentration to the yoghurt while the total solids, ash and titratable acidity increased. For the antioxidant content, the vitamin C levels significantly increased with addition of mango pulp concentration which recorded highest in 22% MPY (4.97) combination. This could lead to an increase in the antioxidant capacity of the yoghurt to scavenge for radicals.

Recommendation

For enhancement of minerals, vitamins and antioxidant capacity of yoghurt drink, acceptable quality can be produced by blending yoghurt with 22% mango pulp combination. This will promote the health benefit of consumers. Also, further research should be done using mango juice rather than pulp and well-trained panelists that are familiar with yoghurt taste during the organoleptic test for sensory evaluation.

References

- Aboul FA, EL-Bassiomy T and EL-Rab HG**, 2005. Milk Product in Soliag City, Assiut. Veterinary Medicine Journal, 14, 81-85.
- Ames BN, Shigenaga MK and Hagen TM**, 1993. Oxidants, antioxidants, and the degenerative diseases of aging. Proceedings of National Academic Science, 90, 7915-7922.
- Atwaa EL, Sayed-Ahmed E and Hassan M**, 2020. Physicochemical, microbiological and sensory properties of low fat probiotic yoghurt fortified with mango pulp fiber waste as source of dietary fiber. Journal of Food and Dairy Sciences, 11, 271-276. 10.21608/jfds.2020.118368.
- Desai SR, Toro VA and Joshi SV**, 1994. Utilization of different fruit in the manufacture of Yogurt. Journal of Dairy Science, 47, 870-874.
- FAOSTATS**, 2019. World mango production. <https://www.statista.com/statistics/577951/>
- Hoque M, Chowhan S and Kamruzzaman M**, 2018. Physiological changes and shelf life of mango (*Mangifera indica* L.) influenced by post-harvest treatments. SAARC Journal of Agriculture, 15, 219-226.
- Hossain MN, Fakruddin M and Islam MN**, 2012. Quality Comparison and Acceptability of Yoghurt with Different Fruit Juices. *Journal of Food Processing and Technology*, 3, 8.
- Jash SK and Brahmachari G**, 2015. Chemical profile and health benefits of fruit mango—An emerging functional food: An update. Signpost Open Access Journal Organizational Biomolecule Chemistry, 3, 1-27.
- Jaster H, Arend GD, Rezzadori, MK, Chaves VC, Reginatto FH and Petrus JCC**, 2018. Enhancement of antioxidant activity and physicochemical properties of yogurt enriched with concentrated strawberry pulp obtained by block freeze concentration. Food Research International, 104, 119-125. <https://doi.org/10.1016/j.foodres.2017.10.006>.
- Jin X, Chen W, Chen H, Chen W and Zhong Q**, 2018. Comparative evaluation of the antioxidant capacities and organic acid and volatile contents of mango slurries fermented with six different probiotic microorganisms. Journal of Food Science, 83, 3059-3068.
- Kebary KMK, El-Sonbaty AH, Kamaly KM and Badawi RM**, 2018. Evaluation of quality attributes of low fat low sucrose symbiotic frozen yoghurt. Egyptian Journal of Dairy Science, 46, 119.
- Kebary KMK, Hamed, AI, Badawi RM, Salem OM and Omar NS**, 2015. Preparation and properties of low-fat ice milk fortified with inulin. Egyptian Journal of Dairy Science, 43, 169.
- Khan K, Rehman SU, Khan MA, Anwar F and Bhadar S**, 2008. Physical and chemical quality appraisal of commercial yoghurt brands sold at Lahore ARPN. Journal of Agricultural and Biological Science, 3, 14-21.
- Monribot-Villanueva JL, Elizalde-Contreras JM, Aluja M, Segura-Cabrera A, Birke A, Guerrero-Analco JA and Ruiz-May E**, 2019. Endorsing and extending the repertory of nutraceutical and

antioxidant sources in mangoes during postharvest shelf life. Food Chemistry, 285, 119-129.

Ning X, Luo Z, Chen Z, Zhou C, Xie C, Du W and Wang L, 2021. Fortification of set yogurt with passion fruit juice: Effects on fermentation kinetics, physicochemical properties, and functionality. Journal of Dairy Science, 104, 4084-4093.

Raut V, Sawant P, Sawant D and Ingole AS, 2015. Studies on preparation of mango yoghurt drink. Asian Journal of Dairy and Food Research, 34, 10.

Ronak P, Jana, HA, Hiral M and Balakrishnan S, 2016. Process standardization for the manufacture of mango flavoured steamed sweetened concentrated yoghurt (Bhapa dahi). Journal of Dairy, Veterinary and Animal Research, 4, 293-303.

Rymbai H, Srivastav M, Sharma RR, Patel CR and Singh AK, 2013. Bio-active compounds in mango (*Mangifera indica* L.) and their roles in human health and plant defence. A review. Journal of Horticultural Science and Biotechnology, 88, 369-379.

Serafeimidou A, Zlatanov S, Kritikos G and Tourianis A, 2013. Change of fatty acid profile, including conjugated linoleic acid (CLA) content, during refrigerated storage of yogurt made of cow and sheep milk. Journal of Food Composition and

Analysis, 31, 24-30.

Shori A and Baba AS, 2014. Comparative antioxidant activity, proteolysis and *in vitro* α -amylase and α -glucosidase inhibition of *Allium sativum*-yogurts made from cow and camel milk. Journal of Saudi Chemical Society, 18, 456-463.

SPSS, 2016. Statistical Package for Social Sciences. SPSS Inc. 13.0 for Windows.

Tanwar B, Andallu B and Chandel S, 2014. Influence of processing on physicochemical and nutritional composition of *Psidium guajava* L. (Guava) products. International Journal of Agriculture and Food Science Technology, 5, 47-54.

Tremblay A and Panahi S, 2017. Yogurt consumption as a signature of a healthy diet and lifestyle. The Journal of Nutrition, 147, 1476S-1480S.

William H and Bowen RA, 2005. Comparison of the Cariogenicity of Cola, Honey, Cattle Milk, Human Milk, and Sucrose. Pediatric, 4, 921-926.

Ziena HM and Abd-Elhamid AM, 2009. Production of functional yogurt: effect of natural antioxidant from guava (*Psidium guajava*) leaf extract. Journal of Agriculture and Food Science Technology, Alexandria University Egypt, 8, 102-116.