Original Research Article

COMPOSITION AND QUALITY EVALUATION OF YOGURT AND WATERMELON JUICE BLENDS

Abstract

The study investigated the effect of incorporation of watermelon juice in yogurt on the quality of the blends. Yogurt and watermelon (*Citrullus lanatus*) juice were produced. The watermelon juice was used to substitute 0, 10, 20, 30, 40, and 50% of yogurt. The chemical composition, antioxidant activity, physicochemical, and sensory properties of the blends were determined using standard procedures. The pH of the yogurt and watermelon juice were 4.57 and 5.78, respectively and varied from 5.18 -6.04 for the blends. The moisture, protein, ash, fat and carbohydrate contents decreased with increase in the amount of watermelon juice in the blends. The vitamin C, calcium, zinc and magnesium contents increased while the phosphorus and potassium contents decreased with increased level of watermelon juice in the blends. The phenols and carotenoids contents increased while the flavonoids content decreased with increase in the level of watermelon juice in the blends. The antioxidant activity using DPPH assay varied with the samples where yogurt had higher radical scavenging activity than the watermelon juice. The radical scavenging activities and the ferric reducing antioxidant property (FRAP) values also increased with the level of watermelon juice in the blends. The FRAP values for yogurt and watermelon juice were 1.22 and 1.58mg/ml, respectively and increased to a range of 1.29 -3.70 for the blends. The yogurt had higher scores than the watermelon juice for all the sensory attributes evaluated. The scores for the sensory attributes decreased with increase in the level of watermelon juice in the blends. However, the scores for the blend containing 10 % watermelon juice for all the attributes were not significantly different ($p>0.05$) from those of the yogurt. Therefore, it is concluded that watermelon juice could be used to substitute 10% yogurt without adversely affecting the qualities of the blends.

Keywords: Proximate composition, physicochemical properties, antioxidant activity, Watermelon, yogurt, Phytochemicals.

1. INTRODUCTION

Yogurt is a fermented dairy product produced by the fermentation of milk with pure culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus*[12] and is consumed worldwide. It is also suitable for people with lactose.It can be manufactured from liquid cow milk, powdered milk and vegetable milk (soy milk) as base material [3]. Lactic acid and the other molecules that are formed during the fermentation of milk make yogurtan acidic and creamy product, appreciated for its taste, nutritional qualities and notably for its calcium content [11].

Yogurtcan be manufactured with probiotic bacteria and has high nutritional and therapeutic values in the human diet [36]. The healthy image of yogurtis due to the probiotic effect of yogurtbacteria.The live lactic acid bacteria (LAB) present in yogurt, have some health benefits that include protection against gastrointestinal upsets, enhanced digestion of lactose by mal-digestion, lower blood cholesterol, in addition to increased hormone response, and it also helps the body to assimilate protein, calcium, and iron [18]. It can be a good carrier for protein and mineral fortification. Fortification of yogurt with whey protein concentrates, fat, fiber, antioxidants, minerals, and other bioactive components has been reported by other studies[36]. However, the use of watermelon juice as additive has not been reported.

Watermelon (*Citrullus lanatus*) belongs to the *Cucurbitaceae* family and is cultivated in almost all the warm regions of the world. It can exist in different colors such as red, orange, and yellow depending on the lycopene and β-carotene contents. It is used as a dessert fruit and a thirst quencher in the very dry parts of Africa; it is relished by both man and domestic/some animals as a source of water. Watermelon is rich in vitamin C, vitamin A, vitamin B, amino acid and also carotenoid, lycopene. The red flesh of watermelon contains some vitamin A [8]. Watermelon contains phenolics, which are mainly hydroxycinnamic acid derivatives and a large amount of lycopene giving its characteristic red color and powerful antioxidant activity. This fruit is free from cholesterol that elevates heart related problems hence,preventing heart attacks[13].Watermelon juice is gaining popularity in recent years due to its sensory, physical, and nutritional characteristics.

Therefore, the objective of the study was to determine the quality of yogurt supplemented with watermelon juice.

2. MATERIALS AND METHODS

Collection of raw materials

The watermelon fruits, cow milk powder, sugar, and lactic acid bacteria starter culturewere purchased from new market in Wukari local Government Area of Taraba State, North East Nigeria. The materials were kept in a refrigerator at 10 ^{o}Cprior use. Reagents used were of analytical grade and were obtained from the Department of Food Science and Technology, Federal University Wukari, Taraba State.

Preparation of yogurt

Yogurt was produced as described by Ibrahim *et al.* (2020) with slight modifications.Powdered milk (1.2 kg) was reconstituted in 12L of warm water (40 °C). The milk sample was mixed and homogenized properly using an electric blender according to Ibrahim *et al*. (2020) . Lukewarm milk (100 ml) pasteurizedat 4 3°C was used to dissolve 2 g of the starter culture containing mixture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* in a sterile beaker. The prepared homogenized milk was pasteurized at 85°C and held at the same temperature for 10 min. The pasteurized milk was cooled to 43°C and inoculated with the prepared starter culture. The inoculated milk was incubated at 43°C in an incubator for 6 h without agitation. The cultured milk (yogurt) was storedat 4°C prior to use.

Preparation of watermelon juice

Watermelon juice was prepared as described byAlam et al. (2013)[7].the fresh and ripe watermelon fruits were washed in clean potable water, cut into halves, and then, the rind and the seeds were removed. The de-seeded fruits were rewashed, drained,cut into cubes and then blended using a fruit processor. The watermelon juice was then collected from the juice cup and pasteurized at 72 ^{0}C for 15 min,cooled to ambient temperature, packaged in plastic containers and then,stored in the refrigerator at 4 ^{0}C prior to use.

Incorporation of watermelon juice into yogurt

The watermelon juice was used to substitute 10, 20, 30, 40, and 50% of yogurt in a food blender that was operated at full speed (3600 rpm) for 10min. The 100% Yogurt served as the control. The samples were packaged in plastic bottles and stored in a refrigerator at 4 ^{0}Cprior to use.

Table 1: Formulation (%) of yogurt and watermelon juice blends

Yogurt	Watermelon Juice
100	0
0	100
90	10
80	20
70	30
60	40
50	50

Analytical methods

Determination of pH, total titratable acidity and total soluble solids of the blends

The pH, total titratable acidity and total soluble solids of the samples were determined using the methods described in AOAC (2010)[9]. For the determination of pH, the pH meter was standardized using buffer solutions of pH 4.0 and 9.0. The pH electrode was dipped into the sample (5 ml) and after a few minutes of equilibration, the pH of the sample was measured. The titratable acidity of the sample was measured by direct titration where the sample (10 ml) was pipetted into each of the two beakers labeled C and S. To the control beaker, 1ml of rosanilline solution was added and stirred. To sample beaker S, 1ml of phenolphthalein indicator was added and titrated with 0.1m NaOH, with continuous stirring until the color matched the pink color of beaker C. The total titratable acidity was then calculated using the formula:TA % = [volume of NaOH used] x [0.1 N NaOH] x [Acid milliequivalent factor] x dilution factor x [100] Volume of sample (ml)

Total soluble solids of the sample was determined in 3 replicates using a hand refractometer and the results was expressed in^{o}Brix[9]

Proximate Analysis of Blends

The proximate composition of the samples (moisture, ash, fiber, protein, and carbohydrate and energy value) was determined using the methods ofAOAC (2010)[9]

Determination of mineral composition of blends

Calcium, Magnesium, Zinc, Phosphorus, Sodium and Potassuimcontents were determined using Atomic Absorption Spectrophotometer (AAS) while Potassium was determined using flame photometry [9]

Determination of vitamin C contents of blends

The method of AOAC (2010)[9] was used to determine the vitamin C content

Determination of phytochemical composition of blends

The total phenol, flavonoids, and carotenoidscontents were determined using the method inAOAC (2010)[9].

Determination of antioxidants activity

The antioxidant activity of the blends was determined using the DPPH scavenging system and the FRAP assay[9] For DPPH, a stock solution was prepared and mixed with methanol to achieve an absorbance of 0.70±0.01 at 516 nm. Samples were left overnight for the scavenging reaction. The FRAP assay involved mixing acetate buffer, TPTZ, and FeCl3.6H2O, and measuring the absorbance change at 593 nm after incubation. Results were expressed as mg of Trolox equivalent per gram of sample.[9]

Sensory Evaluation of the yogurt and watermelon juice Blends

A 9 -point Hedonic scale, where 9 is "like extremely" and 1 is "dislike extremely", as described by [19] was used to evaluate the sensory properties of the yogurt supplemented samples. A 15 -trained panel consisting of students and staff from the Department of Food Science and Technology, Federal University Wukari, Taraba State was used for the evaluation. The panelists were asked to evaluate the samples for flavor, color, taste, texture and overall acceptability on 9-point Hedonic scale. The samples were presented in 3-digit coded white glass cups. The order of presentation of the samples to the panelists was randomized. The sensory evaluation was carried out in the sensory evaluation laboratory under adequate ventilation and lighting. Portable water was presented to the panelists to rinse their mouths between evaluations.

Statistical Analysis

All Analyses were carried out in 3 replicates. The data obtained were subjected to analysis of variance (ANOVA) using the Statistical Package for Social Sciences (SPSS) version 17.0. Means separation was done by Duncan Multiple Range Test (DMRT). Significance was set at $p<0.05$.

RESULTS AND DISCUSSION

3.1 Physicochemical properties of samples of samples

The physicochemical properties of yogurt, watermelon and the blends are presented in Table 2. The total titratable acidity of the watermelon juice (0.5126%) was lower than that of the yogurt (0.7730%), which indicates that the yogurt contained higher acids than the juice. These values were in agreement with the pH, which were inversely related to the total titratable acidity. The pH of the watermelon juice and that yogurt were 5.78 and 4.56%, respectively. Studies by [2] showed that the pH values of yogurt samples ranged between 4.2 and 5.3%, values which were comparable to the result of the present study.According to [20], the typical pH of yogurt is 4.6. The pH of yogurt decreased with increased acidity (TTA), which could be attributed to fermentation. During fermentation, microorganisms use sugars such as lactose and glucose for their metabolic activity and in the process secrete acids   such as lactic acid as by-products. pH, a measure of acidity or alkalinity, is a crucial factor in determining the quality of yogurt.

The pH and TTA (% lactic acid) values in this study differed from those reported by [6], which ranged from 3.9 to 4.1 for pH and 0.5 to 0.75 for TTA. The total titratable acidity of the blends varied from 0.690 -0.986%, which were higher than those of the individual products. The high level of acidity is associated with the fermentation (i.e. break down of milk sugar to lactic acid).The pH of the blends ranged between 5.185 and 6.040, with the blend containing 50% watermelon juice having the highest pH value of 6.04. Acids in food not only improve its palatability but also influence the nutritive value. The acid influences the flavor, brightness of color, stability, consistency and keeping quality of the product [1]. [4] also documented that pH plays dual role of flavor promotion and preservative in fruit juices and fruit products. The low pH of the products is also necessary to prevent alkaline degradation and discoloration during storage [15].

The total soluble solids (TSS) of watermelon juice and yogurt were 10.31and 14.51^{o}Brix, respectively and varied from 8.12-10.19^{o}Brix for the blends. The soluble solids content is one of the most important quality parameters in fruit processing. About 55% of soluble solids are sugars, glucose, fructose, and their amount and proportions influence the organoleptic qualities of fruits. High TSS is desirable as it yields high recovery of processed products.

Table 2: Physicochemical properties of yogurt, watermelon juice and the blends

Samples YG: WMJ	Total titratable acidity (%)	pH	Total soluble solids (°Brix)
0:100	$0.513^{a}\pm0.000$	$5.785^{d}\pm0.007$	$10.31^{a}\pm 0.014$
100: 0	$0.773^{b}\pm 0.007$	$4.565^{a}\pm 0.007$	$14.51^{c}\pm 0.014$
90:10	$0.986^{e}\pm 0.019$	$5.185^{b}\pm 0.007$	$10.19^{g}\pm 0.007$
80:20	$0.965^{c}\pm 0.007$	$5.485^{c}\pm0.134$	$9.61^{e}\pm 0.014$
70:30	$0.764^{b}\pm 0.005$	$5.490^{c}\pm 0.014$	$9.51^{b}\pm 0.014$
60:40	$0.740^{d}\pm 0.028$	$5.775^{d}\pm 0.007$	$8.69^{d}\pm 0.014$
50:50	$0.690^{f}\pm 0.014$	$6.040^{e}\pm 0.014$	$8.12^{f}\pm 0.028$

Values are means± standard deviation of two replicates. Values within a column with the same superscript were not significantly different (p>0.05). *WMJ = Watermelon juice,YG = Yogurt*

3.2 Proximate composition and energy values the samples

The proximate compositions of the samples are presented in Table 3. The moisture content of watermelon juice (68.38%) was higher than that of the yogurt (67.95%). According to [26], the bulk of the fresh pulp and rind of *Citrullus lanatus* and *Cucumis sativus* contain high amount of moisture where the pulp had higher moisture content than the rind. The *Curbitaceae* family contain high amount of water in their fruits, which is useful in hydrating the body. These fruits are used as thirst quencher during hot weather. However, the high moisture content accounts for their rapid deterioration if left unprocessed for long time.

The protein contents of the samples ranged from 9.6– 23.05%and decreased with the level of watermelon juice in the blends due to additive effect since watermelon contained lower protein content than the yogurt. Proteins are responsible for hormone synthesis, and are also used in the buildup of body tissues in addition to playing a role in nutrient transport. The watermelon juice (0.42%) contained higher ash content than the yogurt (0.36%).The ash contents of the blends increased with increase in the amount of watermelon juice due to additive effect.

The fat contents of the samples ranged from 4.0 – 5.1%, with the yogurt having the highest fat content (5.15%). Fat provides the body with energy as it is a good source of energy. The watermelon juice (16.89%) significantly ($p<0.05$) contained higher level of carbohydrate than the yogurt (3.28%). The carbohydrate contents increased with the level of watermelon juice due to additive effect. Carbohydrates help in the supply of energy to blood cells. Glucose is also a good source of energy. The proximate composition of yogurt agreed with that of [15].The energy contents of the watermelon juice and the yogurt were 144.59kcal/g and 148.71kcal/g, respectively and increased with increase in the level of yogurt in the blend .The higher energy content of yogurt was due to its higher fat content.

Table 3: Proximate composition and energy value of yogurt, watermelon juice and the blends

Samples YG:WMJ	Moisture (%)	Protein (%)	Ash (%)	Fat (%)	Crude fiber (%)	Carbohydrate (%)	Energy (kcal/100g)
0:100	68.38^{a}±0.02	9.68^{a}±0.03	0.42^{b}± 0.11	4.79^{b}± 0.11	1.04^{a}±0.1	15.69^{c}± 0.05	144.59
100:0	67.95^{a}±0.40	23.05^{b}±0.78	0.36^{b}± 0.21	5.15^{c}± 0.80	0.95^{a}±0.1	2.54^{a}± 0.00	148.71
90:10	67.13^{a}±0.89	22.45^{c}±1.11	0.27^{a}± 0.02	4.00^{a}± 0.01	0.89^{a}±0.2	5.53^{ab}± 0.14	147.92
80:20	68.03^{a}±0.28	20.37^{b}±0.63	0.37^{b}± 0.19	5.08^{bc}±0.74	0.90^{a}±0.1	5.25^{ab}±0.01	148.20
70:30	68.07^{a}±0.28	19.01^{b}±0.55	0.38^{b}± 0.18	5.04^{bc}±0.66	0.97^{a}±0.2	6.53^{b}± 0.01	147.52
60:40	68.13^{a}±0.25	17.70^{b}±0.48	0.39^{b}± 0.17	5.01^{bc}±0.58	0.99^{a}±0.1	7.78^{b}± 0.02	147.01
50:50	68.13^{a}±0.21	16.36^{b}±0.40	0.39^{b}± 0.16	4.97^{bc}±0.50	1.00^{a}±0.2	9.15^{b}± 0.02	146.77

Values are means± standard deviation of two replicates. Values within a column with the same superscript were not significantly different ($p>0.05$). *WMJ = Watermelon juice, YG = Yogurt*

3.3 Phytochemical composition of the samples

The phytochemical compositions of the samples are presented in Table 4. The flavonoid contents of the samples ranged from 0.60 – 0.77mg/100g. Flavonoids have been reported to lower hepatic lipid peroxidation and stimulate liver regeneration [37]. Flavonoids are generally responsible for prevention of fat oxidation, and protection of vitamins and enzymes, thereby contributing in protection against diseases [35]. The yogurt (0.89mg/100g) contained less amount of phenols than the watermelon juice (2.63mg/ml). According to [14], polyphenols play important functions, like inhibition of pathogens and decay microorganisms, anti-deposition of triglycerides, reduce the incidence of non-communicable diseases such as cardiovascular diseases, diabetes, cancer and stroke; anti-inflammation and anti-allergic effect through processes involving reactive oxygen species. These protective effects are attributed, in part, to phenolic secondary metabolites. The carotenoids content of water melon juice was 5.44mg/ml, which was significantly higher ($p<0.05$) that the 1.78mg/ml of the yogurt. Carotenoid helps to produce color pigment in fruits. The high lycopene pigment in watermelon give the fruit its characteristic color. [25] reported that intake of lycopene is associated with decreased risk of various cancers such as breast, colon, stomach, oral cavity, prostate, and lung cancer

Table 4: Phytochemical composition (mg/100g) of yogurt, watermelon juice and the blends

Samples YG:WMJ	Flavonoids	Phenols	Carotenoids
0:100	$0.77^{a} \pm 0.03$	$2.63^{a} \pm 0.06$	$5.44^{c} \pm 0.03$
100:0	$0.07^{a} \pm 0.08$	$0.89^{a} \pm 0.04$	$1.78^{b} \pm 0.01$
90:10	$0.60^{b} \pm 0.18$	$1.93^{b} \pm 2.90$	$3.45^{a} \pm 0.06$
80:20	$0.65^{a} \pm 0.06$	$2.27^{a} \pm 0.04$	$3.53^{b} \pm 0.01$
70:30	$0.74^{a} \pm 0.05$	$2.40^{a} \pm 0.04$	$3.89^{b} \pm 0.01$
60:40	$0.75^{a} \pm 0.06$	$2.43^{a} \pm 0.05$	$4.25^{bc} \pm 0.02$
50:50	$0.76^{a} \pm 0.05$	$2.55^{a} \pm 0.05$	$4.62^{bc} \pm 0.06$

Values are means ± standard deviation of two replicates. Values within a column with the same superscript were not significantly different ($p>0.05$) .*WMJ= Watermelon juice, YG = Yogurt*

3.4 Mineral composition of the samples

The mineral composition of the samples is presented in Table 5. The phosphorous contents ranged from 0.16 – 0.26mg/ml. Watermelon juice had the highest phosphorous content with the sample containing10% watermelon having the lowestamount of 0.16mg/ml.The potassium contents varied between from 7.85 and 10.49mg/ml. The sample containing 10 % watermelon had the highest value (10.49mg/ml) and yogurt had the lowest content of potassium (7.85mg/ml) .The increase in the blends was due to the supplementation with watermelon juice, which had high content potassium. [17].

The calcium contents of the samples ranged from 3.47–4.74mg/ml. Watermelon juice had the highest calcium content (4.74mg/ml) while the sample containing 10% watermelon had the lowest calcium content (3.47mg/ml). The zinc contents ranged between 0.08 and 0.11mg/ml. Watermelon juice also had higher zinc content (0.11mg/ml) than the other samples The magnesium contents of the samples ranged from 8.47 – 9.10mg/ml. Yogurt had higher content of magnesium (9.10mg/ml) than the other samples. Watermelon juice had the lowest content of magnesium (8.47mg/ml). The magnesium contents decreased with the level of watermelon juice due to additive effect.

Table 5: Mineral composition (mg/ml) of yogurt, watermelon juice and the blends

Samples YG:WMJ	P	K	Ca	Zn	Mg
100:0	$0.18^{b}\pm$ 0.001	$7.85^{a}\pm0.004$	$4.54^{b}\pm0.007$	$0.09^{b}\pm0.001$	$9.10^{c}\pm 0.001$
0:100	$0.26^{c}\pm0.001$	$10.11^{b}\pm0.007$	$4.74^{c}\pm0.003$	$0.11^{c}\pm0.000$	$8.47^{a}\pm0.036$
90:10	$0.16^{a}\pm0.001$	$10.49^{c}\pm0.008$	$3.47^{a}\pm0.002$	$0.08^{a}\pm0.000$	$8.74^{b}\pm0.002$
80:20	0.19 ± 0.001	$8.30^{a}\pm0.004$	$4.59^{b}\pm0.006$	$0.09^{b}\pm0.000$	$8.98^{b}\pm 0.030$
70:30	$0.20^{c}\pm0.001$	$8.53^{a}\pm0.005$	$4.60^{bc}\pm0.006$	$0.10^{c}\pm0.000$	$8.91^{b}\pm0.026$
60:40	$0.21^{c}\pm0.001$	$8.75^{a}\pm0.005$	$4.63^{bc}\pm0.005$	$0.10^{c}\pm0.000$	$8.85^{b}\pm 0.022$
50:50	$0.22^{c}\pm0.001$	$8.98^{a}\pm0.005$	$4.65^{bc}\pm 0.005$	$0.10^{c}\pm0.000$	$8.79^{b}\pm0.019$

Values are means ± standard deviation of two replicates. Values within a column with the same superscript were not significantly different ($p>0.05$). *WMJ = Watermelon juice, YG = Yogurt*

3.5 Vitamin C content and antioxidant activity of samples

The vitamin C contents and the antioxidant activities of the samples are presented in Table 6. The vitamin C contents varied 4.5 – 10.1mg/g. The watermelon juice had higher vitamin C content than the other samples. All the blends had higher amounts of vitamin C than the yogurt.

The DPHH assay is considered as a simple method which gives information on the radical scavenging activity of the antioxidant substances, which exist in a sample [24]. The antioxidant activity obtained using DPPH varied with the samples. The yogurt had lower (27.16 %) radical scavenging activity than the watermelon juice(29.18%). The radical scavenging activity of the blends increased with the level of watermelon juice.The FRAP assay has been reported to be suitable to measure antioxidant activity of substances having half-reaction redox potential below 0.7V [24]. This measures only non-protein antioxidant capacity. Milk component such as urate, ascorbate, f-tocopherol and bilirubin have been characterized to have ferric reducing ability [24]. The results of FRAP assay followed the same trend as the DPPH assay as the watermelon juice had higher FRAP value (1.58mg/g) than the yogurt (1.22mg/g) The samples containing watermelon juice had higher value for FRAP assay than the yogurt. [34] had reported that increase in the antioxidant of food helps to inhibit lipid peroxidation.

Table 6: Vitamin C content and antioxidant activity of yogurt, watermelon juice and the blend

Samples YG:WMJ	Vitamin C (mg/g)	DPPH (%)	FRAP (mg/g)
0:100	10.16^{a}±0.59	29.18^{a} ±0.23	1.58^{a} ±0.021
100:0	4.53^{c}±0.50	27.16^{a}± 0.13	1.22^{b} ± 0.00
90:10	6.03^{b}±0.63	27.54±3.51	1.34^{c} ±0.64
80:20	6.15^{a}±0.59	27.56^{a}±0.21	1.38^{a}± 0.01
70:30	6.22^{b}±0.53	27.76^{a}± 0.20	1.39^{a}±0.01
60:40	6.78^{b}±0.60	27.96^{a}± 0.94	1.43^{a}± 0.01
50:50	7.34^{b}±0.62	27.99^{a}± 0.18	1.45^{ab}± 0.01

Values are means± standard deviation of two replicates. Values within a column with the same superscript were not significantly different ($p>0.05$) .*WM = Watermelon juice, YG = Yogurt, DPPH= 2,2-Diphenyl-1-picrylhydrazyl, FRAP=Ferric educing antioxidant property*

3.6 Sensory properties of the beverages

The sensory properties of the yogurt and watermelon juice blends are presented in Table 7. The scores for taste ranged from 6.6 –8.2. The yogurt had the highest score for taste of 8.2 as against the sample that contained 50% watermelon juice, which had the least score of 6.6. The higher score for 100% yogurt was due to the fact that the panelists are familiar with the taste of yogurt. There was no significant differences (p>0.05) in taste scores of samples containing up to 30% watermelon juice.

The scores for color ranged from 6.8 – 7.8 with yogurt having the highest score. However, there was no significant difference (p>0.05) in the scores for color of the entire samples. There were, however, significant differences in the scores for texture where yogurt was rated highest. According to [38], hydrophilic properties of acid casein gel produced from milk heat treated at 90^0 C had positive influence on the viscosity. The lactic acid bacteria used as a starter culture in the yogurt production may have improved the viscosity of the yogurt, which was decreased in the blends. There were no significant differences (p>0.05) in the texture of the samples containing up to 30% watermelon juice. There was significant difference (p<0.05) in the scores for aroma between yogurt and the other samples, where yogurt received higher score. This is because the yogurt has a unique aroma associated with its fermentation process. All the samples containing watermelon did not differ significantly (p>0.05) in their scores for aroma. The scores for aroma of the beverages were associated with the aroma of watermelon juice. Yogurt had the highest score for general acceptability where the scores decreased with the level of watermelon in the blends. The blend containing 10% watermelon juice had higher score than the other blends, which was not significantly (p>0.05) different from that of yogurt.

Table 7: Sensory properties of yogurt, watermelon juice and the blends

Samples YG:WMJ	Taste	Color	Texture	Aroma	General acceptability.
0:100	$7.47^{ab} \pm 1.06$	$7.67^{a} \pm 0.98$	$7.13^{bc} \pm 1.13$	$6.93^{ab} \pm 0.88$	$7.80^{ab} \pm 0.94$
100:0	$8.20^{b} \pm 0.94$	$7.86^{a} \pm 1.45$	$8.80^{d} \pm 0.41$	$8.53^{c} \pm 0.63$	$8.00^{b} \pm 0.84$
90:10	$7.60^{ab} \pm 1.05$	$7.80^{a} \pm 0.94$	$7.53^{c} \pm 1.12$	$7.33^{ab} \pm 1.11$	$7.46^{ab} \pm 1.05$
80:20	$7.60^{ab} \pm 1.24$	$7.60^{a} \pm 0.91$	$7.46^{bc} \pm 0.88$	$7.26^{bc} \pm 0.97$	$7.33^{ab} \pm 1.17$
70:30	$7.50^{ab} \pm 1.24$	$7.40^{a} \pm 1.59$	$7.43^{c} \pm 1.24$	$6.80^{ab} \pm 1.74$	$7.30^{ab} \pm 1.55$
60:40	$6.43^{a} \pm 1.70$	$6.86^{a} \pm 1.55$	$6.46^{ab} \pm 1.18$	$6.26^{ab} \pm 1.22$	$7.13^{ab} \pm 1.18$
50:50	$6.40^{a} \pm 1.06$	$6.86^{a} \pm 1.95$	$6.20^{a} \pm 1.47$	$6.20^{a} \pm 1.76$	$6.86^{a} \pm 1.76$

Values are means ± standard deviation of fifteen panelists. Values within a column with the same superscript were not significantly different ($p>0.05$). *WMJ = Watermelon juice*, YG = Yogurt

4. CONCLUSIONS

The study showed that yogurt supplemented with 10% watermelon juice had improvement in the sensory,phytochemical, antioxidants, and mineral properties over the watermelon juice and yogurt. Thus, good quality fruity yogurt can be produced from yogurt and watermelon juice.

REFERENCES

1. Adedeji, A.A., Gachovska, T.K., Ngadi, M.O., Raghavan, G.S.V., 2006. Effect of Pretreatmenton the Drying Characteristics of Okra. *Dry. Tech journal*. 26, 1251–1256.

2. Adgidzi, E.A. and Abu, J.O. 2014. Effects of processing methods on the quality of yogurt- likeproducts from tigernut (CyperusEsculentus). *Production Agriculture and TechnologyJournal*, 10(2): 145-156.

3. Adolfsson, O., Meydani, S.N., Russell, R.M, 2004. Yogurt and gut function. *American Journal of Clinical Nutrition*, 80, 245–256

4. Akhtar, S., Ismail, T.,Fraternale, D., &Sestili, P. 2015. Pomegranate peel and peel extracts: Chemistry and food features. Food Chemistry, 174, 417-425. https://doi.org/10.1016/j.foodchem.2014.11.035

5. Akhilender N. K. 2003. Vitamin C in human health and disease is still a mystery? An overview. *Biomed Nutritional Journal*. Vol 2:7

6. Akoma, O. Elekira, U.O,Afodurinbi, A, Onyeukwu, G. C 2000. Yogurt from coconut andtigernuts. *Journal of food technology in Africa*. Vol 5(4)

7. Alam, M. K., Hoque, M. M., Morshed, S., Akter, F., &Sharmin, K. N. 2013. Evaluation ofwatermelon (*Citrullus lanatus*) juice preserved with chemical preservatives atrefrigeration temperature. *Journal of Scientific Research*, 5(2), 407-414. https://www.banglajol.info/index.php/JSR

8. Anon, 2008. Watermelon. *Booklet of Federal Agriculture Marketing Authority (FAMA)*, UtusanPrintcorpSdnBhd

9. AOAC 2010. Official Methods of Analyses. *Association of Official Analytical Chemists. 18th ed*. AOAC.

10. Bagherani N, Smoller B.R, 2016. An overview of cutaneous T cell lymphomas. *F1000Res*; 5.

11. Buttriss J. 2003. Dietary importance. *Encyclopedia of food sciences and nutrition*. Benjamincaballero (Ed) 2nd Edition; 6264-6266.

12. Chandan R.C., Shahami, L.O, 1993. Watermelon juice with pulp. *Konserv. Iovoschesuch. Prom.,* 3, 17–18, 1974

13. Cheng Weidong, Cui Hongwen, Zhang Bingkui, 2002. Analysis of Sugar Content of watermelon (*Citrullus lanatus*(Thunb.) Mansf.), Cucurbit *Genetics Cooperative Report* 25: 30-31.

14. Graf, B.A, Milbury P.E., Blumberg, J.B, 2005. Flavonols, flavanones and human health:Epidemological evidence. *J Med Food 2005*; 8:281- 90

15. Hemalatha, R. and Anbuselvi, S. 2013. Physicochemical constituents of pineapple pulp andwaste.J. *Chem. Pharm. Res*. 5(2):240-242.

16. Halliwell, B. 1999. Vitamin C: poison, prophylactic or panacea? *Trends Biochem. Sci*. 24: 255-259.

17. He F.J, MacGregor G.A, 2007. Salt, blood pressure and cardiovascular disease. *CurrOpin Cardiol*; 22: 298–305.

18. Ibrahim, A.N., Igwe, C.E., Asogwa, J.I., Agbaka, J.I., Ajibo, Q.C., 2020. Influence of *Ocimumgratissimum*(Scent Leaf) on the Organoleptic Acceptability and shelf Stability of Yogurt. *Asian Food Science Journal, 16(1): 28-44*

19. Ihekoronye, A.I, Ngoddy, P.O, 1985. Integrated food science and technology for the tropics.bFirst edition. *Macmillian Education Ltd,* London

20. Lee, W.-J., & Lucey, J. A. 2006. Impact of gelation conditions and structural breakdown on thephysical and sensory properties of stirred yogurts. *Journal of Dairy Science*, 89(6), 2374-2385. © American Dairy Science Association.

21. Lucier, B., Lin, B.H, 2001. Factors affecting watermelon consumption in the United States,U.S. *Int. J. Food Sci. Technol.*2014, 49, 2083–2091.

22. Matkovic V, LandollJ.D,Badenhop-StevensN.E, 2004.Nutrition influences skeletal development from childhood to adulthood: a study of hip, spine, and forearm in adolescent females *JNutr* 2004 :134 ;701S–5S

23. McClements, D. J. 2004. Protein-stabilized emulsions. *Current Opinion in Colloid & Interface Science*, 9(5), 305–313.

24. Najgebauer-Lejko D, Sady M, Grega T, Walczycka M, 2011. The impact of tea Supplementation on microflora, pH and antioxidant capacity of yogurt. *Int Dairy J* 21:568–574

25. Oberoi, D. P. S.; Sogi, D. S, 2017. Watermelon: From dessert tofunctional food. *Israel Journalof Plant Sciences*, 60(4), 395–402.

26. Ozioma, P., Davis, A., & Collins, J. K. 2012. Watermelon: From dessert tofunctional food. *Israel Journal of Plant Sciences*, 60(4), 395–402.

27. Perkins-Veazie, P., Davis, A., & Collins, J. K. 2012. Watermelon: From dessert tofunctionalfood. *Israel Journal of Plant Sciences*, 60(4), 395–402.

28. Pettifor J.M 2008.Vitamin D and/or calcium deficiency rickets in infants and children: a globalperspective. *Indian J Med Res* 127(3):245

29. Pothuraju R, Yenuganti RV, Hissain SA, Sarma M, 2018. Immunity and inflammation in healthand disease. Emerging roles of nutraceuticals and functional foods in immune support. *encyclopedia of Food Sciences and Nutrition. Shampa Chatterjee, Wolfgang Jungraithmayr, and DebasisBagchi* (Ed) 2nd Edition. 433–439.

30. Reid DM, Devogelaer J.P, Saag K, Roux C, Lau C.S, Reginster J.Y, Papanastasiou P, Ferreira A,Hartl F, Fashola T, Mesenbrink P, Sambrook P. N, 2009. HORIZON investigators zoledronic acid and risedronate in the prevention and treatment of glucocorticoidinduced osteoporosis (HORIZON): a multicentre, double-blind, double-dummy,randomized controlled trial.*Lancet* 373(9671):1253–1263

31. Shah Y. V., 2003. Selective crystallization of maltose by isopropanol and acetone from glucose–maltose syrups, *Banat's Journal of Biotechnology* 7(14), 120–125.

32. Tsevdos N. 2018. Yogurt – A food production wiki for public health professionals. *FoodSource Information.* pp. 222 - 236

33. Vallet-Regi N, Gonzalez C.A. (2004) Antioxidant and antibacterial activities of the essential oilsof Ceratonia Siliqua. *Banat's Journal of Biotechnology* 9(17), 13–23.

34. Virtamen, P., Davis, A., & Collins, J. K. 2012. Watermelon: From dessert tofunctional food. *Israel Journal of Plant Sciences*, 60(4), 395–402.

35. Yao L.H., Jiang Y.M. and Shi J, 2004. Flavonoids in food and their health benefits. *PlantFoods for Human Nutrition*, 59(3):113-122

36. Zahoor T, Rahman SU, Farooq U 2002. Viability of *Lactobacillus bulgaricus* as yogurt culture under different preservation methods.*Int. J. Agric. Biol.* 5(1): 46-48.

37. Zhu, Jia, Wang Y., Zhang Y. and Xia M. 2012. The anthocyanin cyanidin-3-o-β-glucoside, aflavonoid, increases hepatic glutathione synthesis and protects hepatocytes againstreactive oxygen species during hyperglycemia: involvement of a cAMPPKA-dependentsignaling pathway. *Free Radical Biology Medicine,* 52(2):314-327.

38. Mottar, J., Bassier, A., Joniau, M., & Baert, J. 1989. Effect of heat-induced association of whey proteins and casein micelles on yogurt texture. *Journal of Dairy Science,* 72(9), 2247-2256. doi: 10.3168/jds.S0022-0302(89)79355-3