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Original Research Report

Proximate Composition and Sensory Evaluation of Spoonable and Drinkable Yoghurt with Watermelon (*Citrullus lanatus*) Pulp and Juice

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Abstract: There is an increasing trend in yoghurt consumption due to the health benefit. Spoonable and drinkable Yoghurt was produced and flavored with graded levels of watermelon pulp (for spoonable) and juice (For drinkable). Watermelon (Citrullus lanatus) juice and pulp were used to substitute 0, 10, 20, 30, 40, and 50% of yoghurt. The proximate and sensory properties of the yoghurts were determined. Results obtained showed that the addition of watermelon pulp and juice extract to the yoghurt had a significant ($p < 0.05$) effect on the parameters analyzed. The protein, fat, ash, fiber and carbohydrate content of drinkable yoghurt samples ranged from 2.10 – 2.65, 1.63 – 2.25, 0.19 - 0.49, 0.61- 0.80 and 9.87 – 9.93 percent, respectively, while sample with watermelon pulp ranged from 3.25 – 4.05, 1.96 – 2.49, 0.26 – 0.37, 1.11–1.96 and 7.40 – 9.50 percent respectively. From the sensory scores, samples DPY +WMJ (90:10) with the lowest level of watermelon juice were most preferred and compared favorably with the control sample based on color, taste, and overall acceptability, although increased levels of watermelon pulp to the spoonable yoghurt were not acceptable to the panelist due to its fibrous taste. The addition of watermelon pulp and juice improved the nutrient value of the yoghurt.

Keywords: Fermentation, Proximate, Sensory scores, Watermelon, Yoghurt

1. Introduction

Yoghurt is a food obtained by controlled fermentation of milk by a mixed culture consisting of *Lactobacillus bulgaricus* (or acidophilus) and *Streptococcus thermophilus* selected to produce flavor and characteristic aroma according to (Savaiano et al., 2020). The milk sugar (lactose) is fermented to lactic acid and causes the quality curd (Astrup, 2014). The lactic acid lowers the pH, makes it flit, causes the milk protein to thicken and act as preservative since pathogenic bacteria cannot grow in an acid condition (Ong et al., 2019). Yoghurt is made by heating milk to a temperature that denaturate its proteins (scalding), essential for making yogurt, cooling it to a temperature that will not kill the live microorganism that turn the milk into yogurt, inoculating certain bacteria (starter culture), usually *Streptococcus thermophilus* and *Lactobacillus bulgaricus*, into the milk, and finally keeping it warm for several hours. The milk may be held at 85 °C (185 °F) for a few minutes, or boiled (giving a somewhat different result) (Rad, 2019). It is usually cooled to 50 °C (122 °F) or somewhat less. Because it may contain live cultures, yogurt is often linked with probiotics, which have been postulated as having positive effects on immune, cardiovascular or metabolic health (Astrup, 2014).

There are different types of yoghurt which includes: frozen, pasteurized, flavored, set, stirred spoonable, drinkable yoghurts among others (Gijsbers et al., 2016). The type of yoghurt produced in this study was spoonable and drinkable yoghurt. Spoonable yoghurt is defined as yoghurt with thicker consistency due to higher total solids (milk) and stabilizers added to form a gel whereas, drinkable yoghurt is essentially stirred yoghurt which has total solid not exceeding 11 % and which has undergone homogenization to further reduce the viscosity. Drinkable yoghurt is produced by diluting the body of stirred yoghurt and mixing it with a blend of fruits, flavors or berry juices. However, flavored yoghurt with various flavor and aroma has become very popular (NIS, 2004). The flavors are usually added at or just prior to filling into pots. flavored yoghurt can be defined as yoghurt in which flavoring agent or other flavoring ingredients such as: Natural flavoring ingredients; fruit (fresh, canned, quick frozen, powdered), fruit puree, fruit pulp, jam, fruit syrup, fruit juice among others and exotic ingredients such as vanilla, strawberry, among others (Panghal et al., 2017).. Fruits and vegetable are important plant foods rich in essential vitamins and minerals but are known to have a short shelf life due to high susceptibility to physiological breakdown postharvest. To this end, there is a need for rapid processing either into a shelf-stable or entirely new product to enhance their shelf life as well as value addition (Panghal et al., 2017).

Furthermore, watermelon (*Citrullus lanatus* thumb) is an indigenous fruit with a lot of health and nutritional benefits. Watermelon is rich in lycopene which is a carotenoid phytonutrient that is especially important for our cardiovascular health, also an antioxidant whose protective effect works wonders on the human body (Martha et al., 2013) and citrulline which is converted to arginine in the kidney (Abdelwaheb et al., 2011). Watermelon juice is also a rich source of minerals such as calcium, potassium, phosphorous among others and vitamins (A and C).

Primarily, tropical fruits undergo post-harvest losses owing to poor post-harvest storage and processing which could be due to mechanical injury, microbiological attack, attack by rodents, insects' pest, storage at a very high temperature among others. This leads to spoilage of the fruits which could be controlled if they are processed into various products (Hong et al., 2012). The use of exotic flavoring makes the product more expensive and can equally have advance effect on our health. Direct consumption of fruits has nutritional benefits and these benefits can still be retained when it is used to fortify food products. In the fortification of yoghurt with vitamins and minerals, solubility and suspension of these additives is sometimes problematic. Yoghurt could be fortified with watermelon pulp and juice to avert this problem and produce more natural products which is one of the market trends to achieve consumers demand for yoghurt (Panghal et al*.*, 2017). The broad aim of this study was to formulate and evaluate spoonable and drinkable yoghurt using watermelon pulp and juice (*Citrullus lanatus)* and to determine the proximate and sensory scores of the formulated yoghurt,

1.1. Statement of Problem

The major problems associated with yoghurt production include storage of the product, high cost of materials and low demand for the product. Primarily, tropical fruits undergo post-harvest losses owing to poor post-harvest storage and processing which could be due to mechanical injury, microbiological attack, attack by rodents, insects' pest, storage at a very high temperature among others. This leads to spoilage of the fruits which could be controlled if they are processed into various products (Hong *et al*., 2012).

The use of exotic/imported or foreign flavoring in yoghurt production makes the product more expensive and can equally have advance effect on our health. Direct consumption of fruits has nutritional benefits and these benefits can still be retained when it is used to fortify food products.

1.2. Purpose of the Study

(a) The purpose of this study was to produce favored spoonable and drinkable yoghurt with watermelon pulp and juice.
(b) To evaluate the sensory attributes of the flavored yoghurt (to check if there is a significant difference in the texture, appearance, color, taste and general acceptability of the yoghurt.
(c) To determine the proximate composition of the formulated flavored yoghurt

1.3. Research Questions

(a) What effect does watermelon have on the proximate composition of yoghurt?
(b) What are the different types of yoghurt?
(c) How does the methodology of spoonable and drinkable yoghurt differ?
(d) Will the addition of watermelon to yoghurt as flavorant be acceptable to consumers?
(e) What makes addition of fruits as flavourant better than exotic flavors?

2. Materials and Methods

2.1. Design for the Study

The design of study used was quantitative/experimental design. The experimental design was completely randomized design (CRD). The data were analyzed using Statistical product for service solution (SPSS) version 20.0 Statistical results were analyzed using a one - way analysis variance (ANOVA) and separated by Duncan's new multiple range tests (DMRT). Significance was accepted at ($p < 0.05$)

2.1.2. Ethics Approval of Research

Ethical permission was not requested from the ethics committee because it is not an animal/human study.

2.2. Procurement of Raw Materials

Ripe watermelon fruit *(Citrullus lanatus)*, was procured from Ikpa market, commercial evaporated full fat (powdered) milk, and starter culture (yoghurmets) were procured from Ogige main market, Nsukka, Enugu State Nigeria.

2.3. Processing of Sample

2.3.1. Production of Watermelon Pulp and Juice

About 2 ripe round shaped watermelon fruit weighing 2.4 kg each was processed. Watermelon fruits were sorted, washed and peeled and seeds removed. The juice was extracted from the fruit using a juice extractor (GE juice extractor, model, 106816, Japan) which separated the pulp from the juice. The resultant juice was pasteurized at 85 ^{0}C for 10 minutes, cooled and packaged into airtight containers. There was a slight reduction of the red color of watermelon after pasteurization. As seen in plate 1.

Plate 1: Watermelon pulp and juice

2.3.2. Production of Spoonable and Drinkable Yoghurt Flavored with Watermelon Pulp and Juice

According to FAO and WHO, (2011), 750 milliter of warm water, 500 grams of milk, 2 teaspoons of carboxyl methyl cellulose and 2 table spoons of sugar were appropriately mixed. The mixed product was homogenized to obtain a creamy and uniform product. Pasteurization was carried out at 85 ^{0}C for 10 minutes to destroy the undesirable micro-organisms (pathogenic and spoilage organisms) in the raw material to provide a favorable environment free from competition for the growth of the live bacteria (*lactobacillus bulgaricus* and *streptococcus thermophilus)*. The product was cooled at 40 ^{0}C and the yoghumet was inoculated, allowed to ferment for 16 hours and set. The watermelon pulp and juice was added at different blends.

2.3.3. Proportion for the Formulation of Spoonable and Drinkable Yoghurt

The informed choice of varying the proportion of the watermelon pulp and juice was due to the fact that watermelon is made of about 90 % water which will affect the overall texture of the final product (flavored yoghurt) hence, a preliminary study was carried out to get the best formulation ratios.

Table 1: Proportion for the production of spoonable yoghurt with watermelon pulp

Sample codes	Spoonable yoghurt (SPY)	watermelon pulp (WMP)
SPY+WMP	100	0
SPY+WMP	90	10
SPY+WMP	80	20
SPY=WMP	70	30
SPY+WMP	60	40
SPY+WMP	50	50

Key: SPY = Spoonable yoghurt; WMP = watermelon pulp

Table 2: Proportion for the formulated drinkable yoghurt with watermelon juice

Sample codes	Drinkable yoghurt(DPY)	Watermelon juice(WMJ)
DPY+WMJ	100	0
DPY+WMJ	90	10
DPY+WMJ	80	20
DPY+WMJ	70	30
DPY+WMJ	60	40
DPY+WMJ	50	50

Key: D PY = plain drinkable yoghurt; WMJ = watermelon juice

Plate 2: Spoonable yoghurt with watermelon pulp

Plate 3: Drinkable yoghurt with watermelon juice

2.4. Sample Analysis

2.4.1. Proximate Composition of the Flavored Spoonable and Drinkable Yoghurt

The composition of the flavored yoghurt with watermelon pulp and juice was determined using appropriate methods

2.4.2. Determination of Moisture Content of the Flavored Spoonable and Drinkable Yoghurt using Watermelon Pulp and Juice

The moisture content of the formulated flavored yoghurt was determined using method described by AOAC (2010). The crucible was thoroughly washed and dried in the oven, afterwards cooled in a desiccator and weighed as (W_1). About 2 ml of the sample was put into the weighed empty crucible and weighed as (W_2), the crucible with the content was transferred into a hot air oven (Fisher Isotemp oven model 175/U.S.A) and dried to a constant weight of 100 ^{0}C. The crucible with the sample was cooled in the desiccator and the weight of the cooled crucible and the content was obtained as W_3

$$\% \text{ Moisture content} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{1}$$

W_1 = weight of empty crucible; W_2 = weight of wet sample + moisture determination crucible;
W_3 = weight of dry sample and crucible.

2.4.3. Determination of crude protein content of the flavored spoonable and drinkable yoghurt

The crude protein of the samples was determined by the semi-micro Kjeldahl technique described by AOAC (2010). A millilitre (1.0 ml) of the sample was put into a Kjeldahl flask. Three grams (3 g) anhydrous sodium sulphate and one (1 g) of hydrated copper sulphate (catalyst) were added into the flask. About 20 ml of concentrated tetraoxosulphate (IV) acid (H_2S0_4) was added to digest the sample. The digestion continued under heat until a solution was observed. The clear solution was then cooled and made up to 100 ml with distilled water and a digest of about 5 ml was collected for distillation. 5 ml of 60 % sodium hydroxide (NaOH) was put into the distillation flask and distillation was allowed to take place for some minutes. The ammonia distilled off was absorbed by boric acid indicator and this was titrated with 0.01 M hydrochloric acid (HCl). The titre value of the end point at which the color changed from green to pink was taken. The crude protein was calculated as:

$$\% \text{ Crude protein} \quad \frac{0.0001401 \times T \times 100 \times 6.25}{W \times 5}$$

Where; T= titre value; W= weight of sample dried.

2.4.4. Determination of Crude Fiber Content of the Flavored Spoonable and Drinkable Yoghurt

Crude fiber was dome using the method of AOAC (2010). About two millilitres of the sample was hydrolysed in beaker with 299 ml of 1.25 % sulphuric acids (H_2SO_4) and boiled for 30 minutes. The mixture was filtered, washed with hot distilled water and boiled again for 30 minutes with 200 ml of 1.25 % of NaOH. The digested sample was also washed with 1 % HCl acid to neutralize the NaOH and then with hot distilled water for several times. The residue was put into weighed crucible and dried at 100 ^{0}C for 2 hours in an air oven, after drying the sample was cooled, weighed and then transferred into a muffle furnace for burning at 500 ^{0}C for 5 hours. The loss in weight was taken and percentage crude fiber was calculated as follow

$$\text{Percent crude fiber} = \frac{\text{Loss in weight (g) after ignition}}{\text{Weight of the original sample}} \times \frac{100}{1}$$

2.4.5. Determination of Crude Fat Content of the Flavored Spoonable and Drinkable Yoghurt

The Solvent extraction method as described by AOAC (2010) was used. The extraction flasks were washed with petroleum ether, dried and cooled and weighed. Two millilitres (2 ml) of the sample were weighed into the extraction thimble. It was placed back in the Soxhlet apparatus. The washed flask was filled to about three quarter of its volume with petroleum ether (that has the boiling temperature range of 40 - 60 ^{0}C). The apparatus was then set-up and extraction carried out for a period of 4 - 6 hours after which complete extraction was made. The petroleum ether was recovered leaving only oil in the flask at the end of the extraction. The oil in the extraction flask was dried in the oven, cooled and finally weighed. The fat content was expressed as a percentage of raw materials. The difference in weight of empty flasks and the flask with oil content which was calculated as:

$$\% \text{ Fat content} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times \frac{100}{1}$$

2.4.6. Determination of Ash Content of the Flavored Spoonable and Drinkable Yoghurt

The determination of ash content of the formulated yoghurt was carried using the method described by AOAC (2010). A preheated and cooled crucible was weighed (W_1) and 2 ml was weighed into the preheated cooled crucible (W_2). The sample was charred. The charred sample in the crucible was transferred into a preheated muffle furnace at 550 ^{0}C for 2 hours until a white and light grey ash is obtained (W_3). It was calculated as:

$$\% \text{ Ash content} = \frac{W_3 - W_1}{W_2 - W_1} \text{ X } \frac{100}{1}$$

Where; W_1 = Weight of empty crucible; W_2 = Weight of crucible + Weight of sample before ashing; W_3 = Weight of crucible + Weight of sample after ashing.

2.4.7. Determination of carbohydrate content of the flavored spoonable and drinkable yoghurt

The carbohydrate content was determined as the nitrogen free extraction calculated by difference as described by james, (1995). The formula below was used:

% Carbohydrate = 100 % - (protein + fat + fibre + ash + moisture) %

2.5. Data analysis and experimental design

Sensory evaluation was done using 20 – man semi-trained panelist and accessed with a 9 – point hedonic scale (where “9” = extremely liked and “1” = extremely disliked.

The experimental design was completely randomized design (CRD). The data were analyzed using a one - way analysis of variance (ANOVA) and separated by Duncan’s new multiple range tests (DMRT). Significance was accepted at ($p < 0.05$) according to Steel and Torrie (1980).

3. Results and Discussion

Table 1 shows the proximate composition of spoonable and drinkable yoghurt blended with graded levels of watermelon pulp and juice

Table 3: Proximate Composition of Spoonable and Drinkable Yoghurt Blended with Graded levels of Watermelon Pulp and Juice

Samples	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate
PY (100:0)	84.07^{cd}±0.07	5.48^{a}±0.00	3.02^{a}±0.02	0.49^{a}±0.05	1.31^{b}±0.05	5.80^{c}±0.21
DPY+WMJ (90:10)	84.19^{c}±0.08	2.65^{cd}±0.02	2.25^{c}±0.05	0.27^{c}±0.05	0.80^{d}±0.05	9.87^{a}±0.11
DPY+WMJ)(80:20)	84.90^{a}±0.00	2.10^{d}±0.40	1.63^{e}±0.13	0.19^{d}±0.05	0.61^{e}±0.05	9.93^{a}±0.15
SPY+WMP(90:10)	84.43^{b}±0.05	4.05^{b}±0.04	2.49^{b}±0.05	0.37^{b}±0.05	1.11^{c}±0.05	7.40^{b}±0.14
SPY+WMP(80:20)	83.25^{d}±0.08	3.25^{c}±0.40	1.96^{d}±0.05	0.26^{c}±0.00	1.96^{a}±0.05	9.50^{a}±0.01

Values are means at ± standard deviation of duplicate determinations. Values bearing different superscripts within the same column are significantly ($p<0.05$) different

Key; PY (100:0) = Plain yoghurt; DPY+WMJ (90:10) = Drinkable yoghurt + watermelon juice; DPY+WMJ (80:20) = Drinkable yoghurt + watermelon juice; SPY+WMP (90:10) = Spoonable yoghurt +watermelon pulp; SPY+WMP (80:20) = Spoonable yoghurt + watermelon pulp

As shown in Table 3, there was an increase in the moisture content of the flavored spoonable and drinkable yoghurt blended with graded levels of watermelon pulp and juice. According to Erhirhie et al. (2013), watermelon has high moisture content which may have attributed to an increase in the flavored yoghurt with watermelon juice except for sample DY+WMJ (80:20). This could be as result of reduction in volume of yoghurt with increase in the volume of watermelon juice. However, the sample containing 10 % watermelon pulp increased slightly in the moisture content. This could be because of the nature of the watermelon pulp (wet pulp) used while sample SPY+WMP (80:20) had the lowest moisture content. This showed that the moisture levels decreased with increase in the concentration of watermelon pulp added The moisture content of sample with range 83.25 to 84.90 % observed in this study was less than the range 85.28 - 87.14 % for formulated yoghurt flavored with solar dried bush mango pulp reported by Mbaeyi-Nwaoha et al. (2017).

The protein content of the flavored spoonable and drinkable yoghurt with graded levels of watermelon pulp and juice ranged from 2.10 % in sample DPY+WMJ (80:20) to 5.48 % in the plain yoghurt sample (100:0). The protein content decreased with the level of watermelon juice and pulp added. The decrease could be probably due to the fact that watermelon juice and pulp have lower protein content compared to milk which agreed with the range of flavored yoghurt range 0f 1.29- 3.52 reported by Mbaeyi-Nwaoha et al. (2017). The variation in the protein content of the flavored yoghurt could be attributed to the fact that fruit has variable composition depending on the locality as reported by Hong et al. (2012).

The crude fat content of the spoonable and drinkable yoghurt flavored with graded levels of watermelon juice and pulp ranged from 1.63 % in the sample DPY+WMJ (80:20) to 3.02 % in the plain yoghurt sample (100:0). Plain yoghurt had the highest fat content. The fat content decreased as watermelon pulp and juice was added. Inuwa et al. (2011) reported that the intake of watermelon boosts the breakdown of fats and watermelon has a fat content of 0.15 g. There was a significant difference in the plain yoghurt and the flavored yoghurt. The fat content of yoghurt varies depending on the product ranging from approximately 10 % fat for full fat Greek style yoghurt to 3 % for whole milk yoghurt, 1.7 % fat for low fat yoghurts and 0.3 % for non-fat yoghurt as reported by (Dairy Council, 2013). The formulated watermelon juice and pulp flavored yoghurt which had fat content ranging from 1.63 - 3.02 % could be referred to as whole milk yoghurt. According to Abdelwaheb et al. (2011), watermelon is a less fat fruit and it is an ideal diet food.

The ash content of spoonable and drinkable yoghurt flavored with graded levels of watermelon pulp and juice ranged from 0.19 % in sample DPY+WMJ (80:20) to 0.49 % in the plain yoghurt sample DPY+WMJ (100:00). The ash content of the flavored yoghurt was lower than the plain yoghurt and the ash content of the flavored yoghurt was significantly different from each other. It was observed that as watermelon juice was added, it decreased the ash content of the yoghurt. This could probably be as a result of the decrease in the volume of the milk due to the high content of the watermelon juice. This could also be because milk is highly rich in minerals some of which are not found in watermelon. Ekere (2014) reported that the ash content of flavored yoghurt with soursop ranged from 1.21 - 1.38 %. The ash content obtained in this study was significantly ($p<0.05$) different.

There was a decrease in the fiber content with the addition of watermelon juice and there was an increase in the fiber content with the addition of the watermelon pulp. The increase in fiber content in the yoghurt with the addition of watermelon juice maybe due to the volume of water present in the watermelon while the increase seen in the pulp maybe due to the fact that the pulp is rich in fiber.

The carbohydrate content of the flavored spoonable and the drinkable yoghurt flavored with graded levels of watermelon pulp and juice ranged from 6.00 % in the plain yoghurt sample (100:0) to 9.93 % in the sample DPY+WMJ (80:20). The carbohydrate content increased with the concentration of the watermelon pulp and juice with sample DPY+WMJ (80:20) having the highest carbohydrate content of 9.93 % and the plain yoghurt sample having the lowest carbohydrate content of 5.80 % There was a significant ($p<0.05$) difference between the plain yoghurt and the flavored yoghurt. The sample DPY+WMJ (80:20) had the highest carbohydrate content. According to Dairy Council (2013), fruit flavored yoghurt has carbohydrate content of 14.0 g /100 g. The increase seen in the flavored samples maybe due to the fact that yoghurt has been sweetened with watermelon since watermelon is made up of mainly water and sugar

Table 4: Sensory scores of yoghurt flavored with graded levels of watermelon pulp and juice.

Sample Codes	Color	Flavour	Mouthfeel	Taste	Aftertaste	Consistency	Overall acceptability
PY (100:0)	8.00^{a} ±0.18	8.65^{a}±0.20	7.10a ±0.20	7.50^{a} ±0.24	7.80^{a}±0.19	8.40^{a}±0.17	8.35^{a}±0.19
DPY+WMJ(90:10)	7.50^{ab}±0.15	6.70^{b}±0.20	7.20^{a}±0.14	7.15^{a}±0.30	6.50^{b}±0.15	7.60^{b}±.0.17	7.00^{b} ±0.15
DPY+WMJ(80:20)	7.25^{b}±0.20	5.95^{c}±0.28	5.80^{b}±0.25	5.55^{b}±0.36	3.35^{d}±0.18	5.50^{c}±0.20	6.25^{c}±0.16
DPY+WMJ(70:30)	5.10^{c}±0.20	4.40^{d}±0.17	3.85^{c}±0.31	5.05^{b}±0.39	4.85^{c}±0.15	4.65^{d} ±0.13	3.50^{d}±0.39
DPY+WMJ(60:40)	5.50^{c}±0.30	4.65^{d}±0.18	4.05^{c}±0.38	2.75^{d}±0.27	3.15^{d}±0.36	3.70^{e}±0.30	2.80^{de} ±0.29
DPY+WMJ(50:50)	3.85^{d}±0.13	2.95^{e}±1.35	4.00^{c}±0.40	3.70^{c}±0.55	3.80^{d}±0.36	3.40^{e}±0.40	2.36^{c} ±0.17
SPY+WMP(90:10)	7.05^{b}±0.25	6.95^{b}±0.20	6.50^{a}±0.13	5.45^{b}±0.29	5.65^{b}±0.40	6.55^{b}±.0.24	5.15^{b} ±0.55
SPY+WMP(80:20)	5.60^{c}±0.37	4.95^{c}±0.20	2.22^{b}±0.26	5.10^{b}±0.19	4.20^{c}±0.40	4.55^{c}±0.40	5.15^{b}±0.55
SPY+WMP(70:30)	4.95^{c}±0.20	5.15^{c}±0.30	2.22^{b}±0.26	3.17^{c}±0.40	2.75^{d}±0.30	3.25^{d} ±0.30	3.10^{c}±0.40
SPY+WMP(60:40)	4.90^{c}±0.30	3.65^{d}±0.40	1.95^{bc}±0.25	2.15^{d}±0.28	4.65^{c}±0.40	4.00$^{c\ d}$±0.30	2.05^{de} ±0.26
SPY+WMP(50:50)	3.90^{d}±0.40	3.65^{d}±0.24	1.35^{c}±0.17	2.55^{d}±0.30	2.70^{d}±0.40	3.65^{d}±0.30	1.35^{d} ±0.17

Values are mean ± standard deviation of twenty panelists. Values in the same column carrying similar superscripts are not significantly ($p>0.05$) different

Key; PY = plain yoghurt (100:00); DPY+WMJ (90:10) = Drinkable yoghurt. + Watermelon juice; DPY +WMP (80;20) = Drinkable yoghurt + watermelon juice; DPY + WMP (70:20) = Drinkable yoghurt + watermelon juice; DPY + WMP (60:40) = Drinkable yoghurt + watermelon juice; DPY + WMP (50:50) = Drinkable yoghurt + watermelon juice. SPY +WMP (90:10) = Spoonable yoghurt + watermelon pulp; SPY + WMP (80:20) = Spoonable yoghurt + watermelon pulp; SPY+WMP (70:30) = Spoonable yoghurt +watermelon pulp; SPY+WMP (60:40) = Spoonable yoghurt + watermelon pulp; SPY+WMP (50:50) = Spoonable yoghurt + watermelon pulp

Table 4 shows that the addition of 10% concentration of watermelon juice produced the most desirable color (7.5), flavor (6.70), mouthfeel (7.20), aftertaste (6.50), taste (7.15), consistency (7.60) and over all acceptability (7.00) which was slightly significant compared with the plain yoghurt. Meanwhile, sample DPY+WMJ (80:20) was slightly significant ($p < 0.05$) from the sample containing 10 % watermelon but was significantly ($p < 0.05$) different from the plain yoghurt sample both in mouthfeel, aftertaste, taste, consistency and overall acceptability. However, the flavor, taste, aftertaste, mouthfeel and overall acceptability of the formulated spoonable yoghurt sample containing 30, 40 and 50 % watermelon pulp were generally disliked while the sample SPY+WMP (80:20) was slightly liked and sample SPY+WMP (90:10) was the most preferred compared to other flavored sample. However, the control which is the plain yoghurt sample PY (100:0) was generally preferred compared to other samples which were expected because watermelon pulp is a new flavor in yoghurt market. In addition, plain yoghurt sample was preferred to the flavored yoghurt because of its thickness, smoothness, body and mouthfeel that was moderately liked.

The findings of this study supports the commercial production of fruit (watermelon) flavored yoghurt to replace the use of exotic flavorings. Fruit flavors occupy a prominent place in consumer preferences. Their versatility invites industry players to explore their power to satisfy consumers' interests. Fruits are a significant source of vitamins, minerals, antioxidants, and other phytochemicals, with high water content (65%-90%) and carbohydrates. The use of exotic flavoring makes the product more expensive and can equally have advance effect on our health. Direct consumption of fruits has nutritional benefits and these benefits can still be retained when it is used to fortify food products. In the fortification of yoghurt with vitamins and minerals, solubility and suspension of these additives is sometimes problematic. Yoghurt could be fortified with watermelon pulp and juice to avert this problem and produce more natural products which is one of the market trends to achieve consumers demand for yoghurt.

The research work is limited in the determination of the yoghurt shelf life with the addition of watermelon pulp and juice. This work is also limited in range to the various methods of producing yoghurt which includes the process development and financial implication of these methods. Nevertheless, there are limiting factors such as, time, money and the reluctance of some manufacturers of yoghurt to make known their process method, unavailability of some raw materials especially the starter culture and unstable power supply. Furthermore, information on the production of fruit flavored yoghurt using sweet ripened watermelon should be circulated to domestic and commercial manufacturers of yoghurts. It is also important that more research be done where watermelon may be incorporated in yoghurt formulation before fermentation rather than being added directly as flavourants. This would reveal more nutritional implication and organoleptic attributes of such products

4. Conclusion

The result of this study showed that spoonable and drinkable yoghurt blended with graded levels of watermelon pulp and juice used as a flavoring agent in the yoghurt had an impact on proximate and sensory properties of the formulated yoghurt. The sensory properties of the formulated yoghurt were preferred by the panelist based on color, taste, flavor, after taste, mouthfeel, consistency and overall acceptability and yoghurt with 10% watermelon pulp and juice was the most preferred samples among others in the formulated flavored yoghurt. This study concluded that sample DPY+WMJ (90:10) and SPY + WMP (90:10) could be produced for consumption and will be acceptable by the consumers. The use of under-utilized fruit such as watermelon which are packed with antioxidants would provide varieties of flavored yoghurt in the market, which are readily available, nutritious and cheap with improved health benefit to the consumers. Based on the result, it is recommended that more research be carried out on the use of the rind of watermelon in order to improve the proximate composition more and health benefit of the yoghurt. Further studies should also be done on the shelf stability of watermelon flavored yoghurt.

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Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

Conceptualization, validation, investigation, methodology, writing draft/article and writing review were carried out by the lead / IST author, data collection and analysis were carried out by the second author. Sensory analysis was conducted by the third and fourth contributors; software was handled by the fifth contributor while supervision, conceptualization, writing review /editing were handled by the sixth contributor.

Data availability Statement

The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

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