Effects of Utazi leaf (*Gongronema latifolium*) and Aloe vera (*Aloe barbadensis*) on the quality attribute of formulated herbal yoghurt

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Abstract

The effect of utazi leave and aloe vera on the quality attribute of formulated herbal yoghurt was studied. Utazi leaf was processed into extract sorting, washing, mashing, sieving, and packaging while aloe vera was processed into paste cleaning, washing, blending, sieving, packaging and refrigeration. Herbal yoghurt was produced from mixture of utazi extract/aloe vera and plain yoghurt at different ratios (WFMA = 297 mL plain yoghurt and 3 mL utazi extract; YC = 300 mL plain yoghurt only; YU1 = 297 mL plain yoghurt + 3 mL utazi extract; YU2 = 294 mL plain yoghurt + 6 mL utazi extract; YAV1 = 297 mL plain yoghurt + 3 mL aloe vera paste; YAV2 = 294 mL plain yoghurt + 6 mL aloe vera paste. The herbal yoghurts samples were subjected to proximate, micronutrients, microbial, phytochemical, sensory properties analysis using standard methods. The proximate composition results of the herbal yoghurt showed that the crude protein varied from 4.75 to 5.75%, fat 3.35 to 4.52%, ash 1.55 to 2.01%, fiber 0.09 to 0.97%, moisture 78.1 to 82.73% and carbohydrate 6.99 to 10.20%. Calcium, Magnesium, vitamin A and E contents ranged from 13.95 to 14.52, 0.90 to 2.50, 1.99 to 3.55 and 5.00 to 6.00 mg/100 g^{-1}, respectively. Microbial results showed that the mould count for the control (YC) had higher total viable count $15x10^7$ (CFU/mL^{-1}) and higher mould count $15x10^7$ (CFU/mL^{-1}) compared to the composite herbal yoghurt. The phytochemical analyses of the herbal yoghurt values showed tannin to range between 0.12 and 0.51%, alkaloids 1.05 to 4.10 % and saponin ranged from 2.05 to 5.05. The sensory results of the herbal yoghurt showed that taste ranged from 6.15 to 7.35, consistency 6.35 to 6.95, appearance 6.70 to 7.45, mouthfeel 6.20 to 720, aroma 6.30 to 7.30, aftertaste 5.00 to 7.15 and over all acceptability ranged from 6.20 to 8.00.

Keywords: utazi leaf, aloe vera, herbal yoghurt, *Aloe* genus, *Gongronema* genus.

Efeitos da folha de Utazi (*Gongronema latifolium*) e Aloe vera (*Aloe barbadensis*) sobre o atributo de qualidade de iogurte formulado à base de plantas

Resumo

O efeito da folha de utazi e aloe vera no atributo de qualidade do iogurte formulado à base de ervas foi estudado. A folha de utazi foi processada para separação de extratos, lavagem, trituração, peneiramento e embalagem, enquanto o aloe vera foi processado para limpeza de pasta, lavagem, mistura, peneiramento, embalagem e refrigeração. O iogurte de ervas foi produzido a partir da mistura de extrato de utazi/aloe vera e iogurte natural em diferentes proporções (WFMA = 297 mL de iogurte natural e 3 mL de extrato de utazi; YC = 300 mL apenas de iogurte natural; YU1 = 297 mL de iogurte natural + 3 mL de extrato de utazi; YU2 = 294 mL de iogurte natural + 6 mL de extrato de utazi; YAV1 = 297 mL de iogurte natural + 3 mL de pasta de aloe vera; YAV2 = 294 mL de iogurte natural + 6 mL de pasta de aloe vera. Análise das propriedades sensoriais usando métodos padrão. Os resultados da composição aproximada do iogurte à base de plantas mostraram que a proteína bruta variou de 4,75 a 5,75%, gordura 3,35 a 4,52%, cinzas 1,55 a 2,01%, fibra 0,09 a 0,97%, umidade 78,1 a 82,73% e carboidratos 6,99 a 10,20%. Os teores de Cálcio, Magnésio, vitamina A e E variaram de 13,95 a 14,52, 0,90 a 2,50, 1,99 a 3,55 e 5,00 a 6,00 mg/100 g^{-1}, respectivamente. Os resultados microbianos mostraram que a contagem de fungos para o controle (YC) teve maior contagem total viável $15x10^7$ (UFC/mL^{-1}) e maior

contagem de fungos $15x10^7$ (UFC/mL^{-1}) em comparação com o iogurte de ervas composto. As análises fitoquímicas dos valores de iogurte à base de ervas mostraram taninos variando entre 0,12 e 0,51%, alcaloides 1,05 a 4,10% e saponinas variando de 2,05 a 5,05. Os resultados sensoriais do iogurte herbal mostraram que o sabor variou de 6,15 a 7,35, a consistência de 6,35 a 6,95, a aparência de 6,70 a 7,45, a sensação na boca de 6,20 a 720, o aroma de 6,30 a 7,30, o sabor residual de 5,00 a 7,15 e a aceitabilidade geral variou de 6,20 a 8,00.

Palavras-chave: folha de utazi, aloe vera, iogurte de ervas, gênero *Aloe*, gênero *Gongronema*.

1. Introduction

Vegetables present a valuable source of nutrient and are low in calories. These are rich in dietary fibre, minerals as well as many bioactive compounds such as antioxidants such as carotenoid, ascorbic acid, tocopherol, phenolic substances. Supplementation of yoghurt with selected vegetables provide additional health properties and result in the effects which are higher in dairy foods added with herbs (Ugochukwu; Babady, 2022).

Gongronema latifolium, commonly called 'utazi' and 'arokeke' in the Southwestern and Southeastern parts of Nigeria, is a tropical rainforest plant primarily used as spice and vegetable in traditional folk medicine (Ugochukwu; Babady, 2002; Ugochukwu et al., 2003). The leaves are rich in fats, proteins, vitamins, minerals, and essential amino acids. Properties experience has shown that the whole plant exhibit the following herbal actions: analgesic, antitumor, broad-spectrum, development of novel functional dairy products (Damunupola et al., 2014). Also, antioxidants, antimicrobial, antihypertensive antimicrobial (antibacterial, antifungal, antiparasitic and antiviral) antipyretic, antioxidant, antiflammatory, antiulcer, anti-sickling, antiasthmatic, mildexpectorant, hypoglycemia, hypolipidemic, hepaprotective, digestive tonic and laxative properties (Damunupola et al., 2014).

The main functional component in aloe vera is the polysaccharide acemannan (Salah et al., 2017). This component is the responsible of the beneficial properties attributed to *Aloe vera*, these properties include the reduction in blood glucose, blood pressure and the improvement of lipid profile in diabetic patients among many others (Atherton, 2007). Aloe vera has been used in yoghurt, since aloe has shown a good viability of probiotic cultures (Panesar; Shinde, 2012).

Aloe vera is known for its antibacterial, antiviral, antioxidants, and antiseptic properties. Yoghurt contain reasonable quantity of fat globules referred to as milk fat, it is prone to oxidation and produce off flavors. However, there are some vegetables that possess anti-oxidative, anti-microbial and anti-inflammatory properties which if incorporated in yoghurt to avert the off flavor. The consumption of yoghurt is limited by some people such as diabetic patients. Therefore, there is need to provide substitute to plain yoghurt. Herbal yoghurt could serve as such alternative to plain yoghurt to provide the combined health benefits from vegetables plus those from the healthy bacteria present in the yoghurt (Panesar; Shinde, 2012).

Nutrients which emanate from vegetables (utazi leaves) or herbs (*Aloe vera*) which could be added to plain yoghurt to add variety, improve its nutritional content and medicinal values by exhibiting antioxidants, anti-inflammatory, antiulcer, antibacterial herbal actions for people with diabetes, lactose intolerance gastrointestinal disorders. By so doing, value would be added to aloe vera and utazi leave which is presently underutilized in this part of the world.

The main objective of this work was to investigate the effect of utazi leaf (extract) and aloe vera on the quality attributes of herbal yoghurt.

2. Materials and Methods

The materials used in this work includes, dried milk, granulated sugar, yoghurt culture, Utazi leaves and *A. vera*. All the raw materials were purchased from Ogige main market in Nsukka, Enugu State of Nigeria.

2.1 Preparation of utazi leave extract

The utazi leaves were first cleaned and washed thoroughly from visible contaminants and rinsed with distilled water. The wet leaves were ground in a blender (Kenwood BL335) and the water was filtered using a muslin cloth. Figure 1 shows the processing of utazi leave extract.

Figure 1. Processing of utazi leaf extract. Source: Ibrahim et al. (2020).

2.2 Preparation of aloe vera paste

The aloe vera leaves were thoroughly washed were allowed to drain. The gel was scooped into a blender (Kenwood BL335) and blended until the gel becomes frothy and liquefies. The aloe vera paste were then sieved with a mesh size of 0.20 mm to get a smooth aloe vera paste. The paste were packaged in airtight containers and used immediately. The preparation of aloe vera paste is shown in (Figure 2).

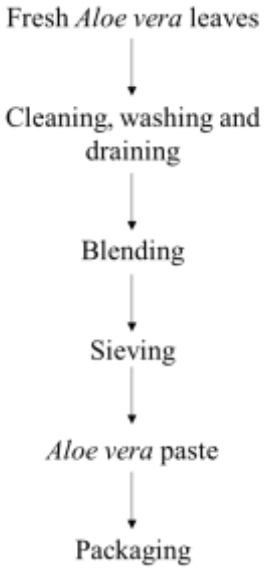

Figure 2. Preparation of aloe vera paste. Source: Mahuli & Anandamony, (2020).

2.3 Production of herbal yoghurt samples

The yoghurt mix was pasteurized at 80 °C for 60 sec. This was followed by homogenization of the yoghurt sample using a blender which helped to homogenize all the ingredients and also helped to break down fat globules in milk into smaller more consistently dispersed particles which gave a smoother and creamier product. Cooling to inoculation temperature of 40 - 43 °C was done to achieve the cooling effect that is suitable for the

culture.

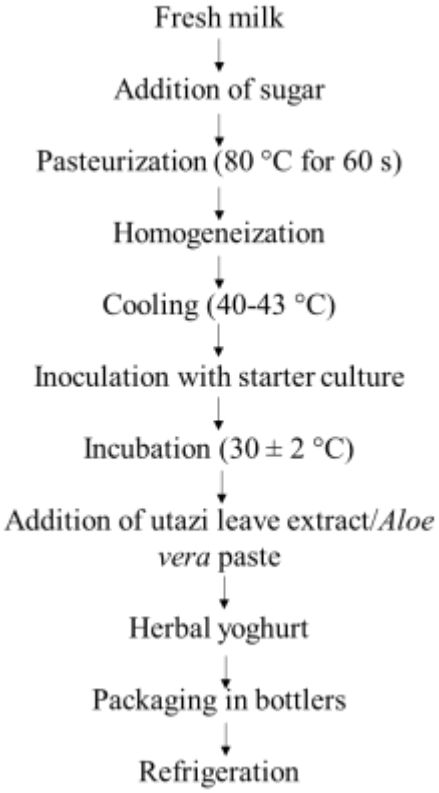

Figure 3. Production of herbal yoghurt. Source: Tamine & Robinson, (2004).

2.4 Yoghurt formulation

Table 1 describes the yogurt formulation (utazi extract/aloe vera paste).

Table 1. Blending ratio of yoghurt, utazi leave extract/aloe vera paste for herbal yoghurt.

Sample Code	Yoghurt (mL)	Utazi leave extract (mL)	Aloe vera (mL)	Herbal yoghurt (mL)
YC	300	_	_	_
YUL1	297	3	_	300
YUL2	294	6	_	300
YAV1	297	_	3	300
YAV2	294	_	6	300

Note: Key: YC = Plain yoghurt (control); YUL1 = Herbal yoghurt fortified with 3 mL utazi leave extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leave extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; YAV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. Source: Authors, 2023.

2.5 Determination of proximate composition of herbal yoghurt

Proximate composition was carried out on the herbal yoghurt to determine the moisture, ash, crude fiber, fat, protein, and carbohydrates content.

2.5.1 Moisture content

The moisture content was determined by hot air oven methods as described by AOAC (2010).

2.5.2 Ash content

Ash content was determined using AOAC (2010) method.

2.5.3 Crude Fiber

Crude fiber was determined using the AOAC (2010) method.

2.5.4 Fat content

The Soxhlet extraction described method described by AOAC (2010) was used to determined fat content of the samples.

2.5.5 Protein content

The micro Kjeldahl method as described by AOAC (2010) was used to determine crude protein.

2.5.6 Determination of carbohydrate content

The carbohydrate Content was calculated by difference according to AOAC (2010).

2.5.7 Micronutrient analyses of herbal yoghurt

2.5.7.1 Determination of mineral content

The mineral content of the herbal yoghurt was determined using the method described by AOAC (2010).

2.5.8 Determination of vitamin A

Vitamin A content was determined according to the method described by Onwuka (2005).

2.5.9 Determination of vitamin E

The Vitamin E content of the herbal yoghurt was determined using the method described by AOAC (2010).

2.6 Phytochemical prospecting

Phytochemical analyses was carried out, as described by Okwu (2005).

2.6.1 Test for tannins

A few drops of 0.1% ferric chloride were added to the yoghurt samples and observed for brownish green or a blue-black coloration.

2.6.2 Test for saponins

For saponin test, 10 mL of the yoghurt sample was mixed with 5 mL of distilled water and shaken vigorously until a stable froth is obtained. The froth formed was then mixed with 3 drops of olive oil, and eventually shaken vigorously. The mixture was observed for the formation of an emulsion.

2.6.3 Test for alkaloids

A modified method of Oladoso-Ajayi et al. (2017), was used. Here, 5 g of the yoghurt samples were weighed into a 250 mL beaker and 200 mL of distilled water was added, covered, and allowed to stand for 4 h. This was filtered and the extract was concentrated on a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added dropwise to the extract until the precipitation was complete. The whole solution was allowed to settle, and the precipitate collected and washed with diluted ammonium hydroxide and then filtered. The residue was the alkaloid, which was dried and weighed.

2.7 Microbial analysis

Microbiological analysis was carried out on the yoghurt samples. A serial dilution of the sample was done. The sample was placed at ambient temperature. Total viable count was performed at intervals of 1 h within the fermentation period. Total viable count (TVC) and mould count was determined by pour plate method on nutrient agar and Sabauroud Dextrose Agar (SDA), respectively as described by Prescott et al. (2005).

2.7.1 Total viable count

The brad was dissolved into 9 mL of ringer solution in a test tube and mixed thoroughly by shaking. This was 10^{-1} dilution; one millimeter (1 mL) of the mixture was pipette into another 9 mL Ringers solution to give 10^{-2} dilution. The *Petri* dishes were duplicated for each sample and in each plate, 15 mL of sterile nutrient agar

medium was added, and 1 mL of each sample dilution was pipette into each medium-containing plate, respectively. This was followed by shaking in a circular movement for about 10 sec to enhance mixing. The plates were allowed to set and were incubated (inverted) for 48 h at 37 °C. The colonies formed was counted and recorded as colony forming units (CFU/mL^{-1}).

No of colonies (CFU/g^{-1}) = average × dilution factor (DF)

2.7.2 Mould count

The method to be used for the total viable count was applied in mould count determination, except that Sabouraund Dextrose Agar (SDA) was used to prepare the medium and the incubation period was for 72 h at 25 °C.

2.8 Sensory evaluation

The sensory evaluation was carried out according to Ihekoronye & Ngoddy (1985) using a 20 man semi-trained panelist. The panelists were instructed to indicate their preference of the samples. According to Iwe (2002), a nine-point Hedonic scale, where 9 was the highest score and 1 was the lowest score for each characteristic such as colour, flavour, taste, mouth feel, and overall acceptability was determined.

2.9 Data analysis and experimental design

The experimental design was laid out in Completely Randomized Design (CRD). All data was subjected to Analysis of variance (ANOVA) using SPSS (Statistical Package for the Service Solution) version 20. Means were be separated using *Ducan's* multiple range test (DMRT). Significant was be accepted at $p < 0.05$.

3. Results and Discussion

3.1 Formulation of the utazi leaf extract and Aloe vera paste (Figure 3)

Figure 3. Utazi leaf extract (*Gongronema latifolium*). Source: Authors, 2023.

Figure 4. Aloe vera paste (*Aloe barbadensis*). Source: Authors, 2023.

3.2 Production of herbal yoghurt with varying levels of utazi leaves and aloe vera

Figure 5. Herbal yoghurt samples. Note: Key: YC = Plain yoghurt (control); YUL1 = Herbal yoghurt fortified with 3 mL utazi leave extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leave extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; YAV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. Source: Authors, 2023.

3.3 Proximate composition of herbal yoghurt flavoured with utazi leaf extract/aloe vera

The results of the proximate composition of herbal yoghurt flavoured with utazi leave extract/ aloe vera were represented in (Table 2).

3.3.1 Moisture content

The moisture content of the herbal yoghurt ranged between 78.10 to 82.73% with sample YAV2 having the lowest moisture content and sample YUL2 having the highest moisture content. The moisture content of the herbal yoghurt sample YUL1 and AV1 which had moisture content of 81.05 and 71.7, respectively were not significantly ($p < 0.05$) different from the control (YC) which had the moisture content of 80.04. It was observed that the moisture content of the herbal yoghurt increased with an increase in utazi leave extract. This might be due to the increase in water content (used in the utazi leave extraction process) in the herbal yoghurt. The recorded moisture content for the herbal yoghurts is slightly lower than that reported by Ahmad (1994), he

reported that moisture content of yoghurt should be between 82-84%.

3.3.2 Crude protein

The crude protein of the herbal yoghurt ranged between 4.75 to 5.75 % with sample YC having the lowest crude protein and sample YUL2 having the highest crude protein. There were no significant ($p < 0.05$) difference between the control sample (YC) which had a crude protein percentage of 4.75 and the herbal yoghurt sample; YUL1, AV1 and AV2 having the crude protein value of 5.02, 4.80 and 4.91% respectively. The percentage crude protein of the herbal yoghurts were higher than that of the plain yoghurt. This might be due to the restraining effect of the phytochemical component of the herbs on the bacteria strain which was used as cultures during the production. These cultures act on lactose to produce lactic acid, coagulating milk in the process and giving yoghurt its characteristic texture

3.3.3 Ash content

The ash content of the herbal yoghurt samples varied from 1.55 to 2.01% with sample YC (plain yoghurt) having the least ash content while sample YAV2 (herbal yoghurt fortified with 6ml aloe vera paste) had the highest ash content. There were significant ($p < 0.05$) differences between the control (YC) and all the herbal yoghurt samples. It was observed that the herbal yoghurts had higher ash content than the plain yoghurt. The reduction in ash content of the plain yoghurt the reduction in ash content could indirectly be related to the loss of some minerals during the processing of yoghurt and some of the minerals were replaced when utazi/aloe vera extract was added to the yoghurt, thus, making the herbal yoghurt have higher ash content.

3.3.4 Crude fat

The fat content of the herbal yoghurt varied between 3.35 to 4.52% with sample YC (plain yoghurt) having the least fat content and sample YUL2 (herbal yoghurt fortified with 6ml utazi leave extract) having the highest fat content. There were significant ($p < 0.05$) differences between the control (YC) and all the herbal yoghurt samples (YUL1, YUL, YAV1 and YAV2). The fat content of the herbal yoghurt increased with the addition of utazi/ aloe vera extract. According to Oladipo et al. (2014), the fat composition of yoghurts has a crucial impact on its consistency (texture) and flavour.

Table 2. Proximate composition of herbal yoghurt flavoured with utazi leave extract/aloe vera paste.

Sample Code	Mositure (%)	Protein (%)	Ash (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
YC	80.4^{bc}±0.42	4.75^{a}±0.35	1.55^{a}±0.01	3.35^{a}±0.07	0.09^{a}±0.42	9.05^{b}±0.02
YUL1	81.05^{c}±0.07	5.02^{a}±0.03	1.73^{b}±0.04	4.35^{d}±0.07	0.83^{a}±0.05	6.99^{a}±0.01
YUL2	82.73^{d}±0.49	5.75^{b}±0.72	1.81^{c}±0.01	4.52^{d}±0.03	0.97^{a}±0.03	6.99^{a}±0.01
YAV1	79.7^{b}±0.14	4.80^{a}±0.28	1.88^{c}±0.01	3.60^{b}±0.14	0.87^{a}±0.01	9.60^{c}±0.42
YAV2	78.1^{a}±0.14	4.19^{a}±0.21	2.01^{d}±0.02	3.81^{c}±0.01	0.95^{a}±0.07	10.20^{d}±0.01

Note: Values are means of duplicate determinations ± standard deviation. Means with different superscript in the same column are significantly ($p > 0.005$) different. Key: YC = Plain yoghurt (control); YUL1 = Herbal yoghurt fortified with 3 mL utazi leave extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leave extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; YAV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. Source: Authors, 2023.

3.3.5 Crude fiber

The fiber content of the herbal yoghurt varied between 0.09 to 0.97% with sample YC (plain yoghurt) having the least fat content and sample YUL2 (herbal yoghurt fortified with 6ml utazi leave extract) having the highest value. It was observed that the fiber content of the yoghurt increased with the addition of utazi/ aloe vera with the yoghurt containing utazi extract having higher fiber. There was significant ($p < 0.05$) difference between the herbal yoghurt and the control. The increased fiber content of the herbal yoghurt shows that the herbal yoghurt fortified with utazi/ aloe vera extract is healthy and effective in maintaining bowel health, controlling blood sugar, and achieving healthy weight.

3.3.6 Carbohydrate

The carbohydrate content of the herbal yoghurt varied from 6.9 to 10.20% with sample YUL2 having the lowest carbohydrate and YAV2 having the highest carbohydrate. There was no significant ($p < 0.05$) difference between all the herbal yoghurt samples and the control (YC). It was observed that the carbohydrate content of sample YUL1 and YUL2 was lower than the carbohydrate content of the control (YC). The variation in carbohydrate content of control and composite bread could be due to the differences in the contents of other components such as protein, fat, fiber, and ash.

3.4 Micronutrient composition of herbal yoghurt flavoured with utazi leaf extract/aloe vera paste

The results of the micronutrient composition of herbal yoghurt samples were shown in (Table 3).

3.4.1 Calcium (Ca)

The Ca content of the herbal yoghurt varied from 14.00 to 14.52 mg/100 g^{-1}, with sample YC having the lowest calcium content and sample YAV2 having the highest Ca content. There were significant ($p < 0.05$) differences between the herbal yoghurt and the control (plain yoghurt). It was observed that the addition of utazi leave extract and aloe vera paste slightly increased the Ca content of the herbal yoghurt. The result justifies the assertion of Grey (2002) that yoghurt is very good source of essential minerals needed for human metabolism or functionality of cells.

3.4.2 Magnesium (Mg)

The Mg content of the herbal yoghurt varied from 0.90 to 2.50 mg/100 g^{-1} with sample YC having the lowest Mg content while sample YUL2 had the highest magnesium content. There were significant ($p < 0.05$) differences between the control (YC) and all the herbal yoghurt samples. It was observed that the Mg content was higher in the herbal yoghurt than the plain yoghurt and this is due to the addition of utazi leave extract and aloe vera paste to the yoghurt. A similar increase was observed by Ihemeje et al. (2013) where pepper fruit was used in zobo drink production.

3.4.3 Vitamin A

The vitamin A content of the herbal yoghurt varied from 5.00 to 6.00 mg/100 g^{-1} with sample YAV2 having the lowest pro-vitamin A content while sample YUL2 had the highest pro-vitamin A content. There were significant ($p < 0.05$) differences between the control (YC) and all the herbal yoghurt samples. Addition of utazi leave extract and aloe vera paste caused improvement in the pro-vitamin A content of the yoghurt.

3.4.4 Vitamin E

The vitamin content of herbal yoghurt varied from 1.99 to 3.55 mg/100 g^{-1} with sample YC having the lowest vitamin E content while sample YUL2 had the highest vitamin E content. There were significant ($p < 0.05$) differences between the control (YC) and all the herbal yoghurt samples. It was observed that the vitamin E content of the herbal yoghurt were higher than that of the plain yoghurt. Similar trend of increase in vitamin E content of flavoured and spiced yoghurt was respectively recorded by Ihemeje et al. (2015).

Table 3. Micronutrient composition of herbal yoghurt flavoured with utazi leaf extract/ aloe vera paste.

Sample code	Calcium (mg/100g)	Magnesium (mg/100g)	Vitamin A (mg/100g)	Vitamin E (mg/100g)
YC	14.52e±0.001	0.90^{a}±0.001	5.20^{a}±0.001	1.99^{a}±0.001
YUL1	14.20c±0.001	2.00^{d}±0.001	5.80^{c}±0.001	2.89^{d}±0.001
YUL2	14.39d±0.001	2.50^{e}±0.001	6.00^{d}±0.001	3.55^{e}±0.001
YAV1	13.95a±0.001	1.00^{b}±0.001	5.32^{b}±0.001	2.19^{b}±0.001
YAV2	14.00^{b}±0.001	1.50^{c}±0.001	5.00^{c}±0.001	2.79^{c}±0.001

Note: Values are means of duplicate determinations ± standard deviation. Means with different superscript in the same column are significantly ($p > 0.005$) different. Key: YC = Plain yoghurt (control); YUL1 = Herbal yoghurt fortified with 3 mL utazi leave extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leave extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; YAV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. Source: Authors, 2023.

3.5 Phytochemical composition of herbal yoghurt flavoured with utazi leaf extract/aloe vera

The results of the phytochemical composition of herbal yoghurt flavoured with utazi leave extract/ aloe vera were represented in (Table 4).

3.5.1 Tannin

The tannin content of herbal yoghurt varied from 0.12 to 0.51% with sample YC having the lowest tannnin content while sample YUL1 had the highest tannin content. There were significant ($p < 0.05$) differences between the control (YC) and all the herbal yoghurt samples. It was observed that the tannin content of the herbal yoghurt were higher than that of the plain yoghurt. This could be attributed to the addition of utazi leave extract and aloe vera which have high phytochemical components (such as tannin) to the yoghurt.

3.5.2 Alkaloids

The alkaloid content of herbal yoghurt varied from 1.05 to 4.10% with sample YC having the lowest alkaloid content while sample YAV1 and YAV2 have the highest alkaloid content. There was no significant ($p < 0.05$) difference between the control (YC) and samples YUL1 which contain 2.80% alkaloid. It was observed that the alkaloid content of the herbal yoghurt were higher than that of the plain yoghurt. The alkaloids are known for their antioxidant, antibacterial (Karou et al., 2005), anti-insecticidal, and anti-parasitic properties (Fernandez et al., 2010).

3.5.3 Saponin

The saponin content of herbal yoghurt varied from 2.05 to 5.05% with sample YC having the lowest alkaloid content while sample YAV2 had the highest saponin content. There were significant ($p < 0.05$) differences between the control (YC) and the herbal yoghurt samples (YUL1, YUL2, YAV1 and YAV2). The saponins present in the herbal have been reported to have good antibacterial properties, anti-inflammatory, and immune-boosting properties (Savage, 2003).

3.6 Microbial count of herbal yoghurt flavored With utazi leaf extract/ aloe vera paste

Table 4 shows the total viable count and mould count of yoghurt flavoured with utazi leaf extract/aloe vera paste.

3.6.1 Total viable count (TVC)

The result in Table 5 shows that sample YC (plain yoghurt) which is the control had the highest total viable count of $1.5x10^6$ (CFU/g^{-1}) while sample YUL2 has the lowest total viable count of $5x10^5$ CFU/mL^{-1}. It is observed from the table that herbal yoghurts have lower total viable count compared to the plain yoghurt. This could be due to the antimicrobial and antifungal effect of the phytochemicals present in the utazi leaf extract and aloe vera paste. This could mean that the herbal yoghurt could have longer shelf life compared to the plain yoghurt as the phytochemicals present in the herbs inhibit the rapid growth of of spoilage microorganisms in the herbal yoghurt.

3.6.2 Mould count

The result showed that the mould count for the herbal yoghurt were undetected for sample YUL2 while sample YC (control) had the highest mould count of $1.5x10^6$. The absence of mould in sample YUL2 could be attributed to the antimicrobial effect of utazi leave. Damunupola et al. (2014) reported that yeast and mould count was no growth in plain and beetroot incorporated goat milk yoghurt.

Table 4. Phytochemical composition of herbal yoghurt flavored with utazi leave extract/ aloe vera paste.

Sample	Tannin (%)	Alkaloids (%)	Saponin (%)
YC	0.12^{e}±0.04	1.05^{d}±0.07	2.05^{f}±0.07
YUL1	0.51^{a}±0.01	2.80^{d}±0.01	3.05^{e}±0.07
YUL2	0.40^{b}±0.01	3.05^{c}±0.07	4.05^{c}±007
YAV1	0.40^{b}±0.01	4.10^{b}±0.14	3.55^{d}±0.07
YAV2	0.29^{c}±0.01	4.10^{b}±0.14	5.05^{a}±0.07

Note: Values are means of duplicate determinations ± standard deviation. Means with different superscript in the

same column are significantly ($p < 0.05$) different. Key: YC = Plain yoghurt (control); YUL1= Herbal yoghurt fortified with 3 mL utazi leaf extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leaf extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; YAV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. Source: Authors, 2023.

Table 5. Microbial count of herbal yoghurt flavored with utazi leave extract/aloe vera paste.

Sample	Total Viable Count (CFU/mL)	Mould Count (CFU/mL)
YC	1.5×10^6	1.5×10^6
YUL1	1.0×10^6	1.0×10^6
YUL2	5.0×10^5	N.D
YAV1	1.0×10^6	1.0×10^6
YAV2	1.0×10^6	1.0×10^6

Note: Values are means of duplicate determinations. Key: YC = Plain yoghurt (control); YUL1 = Herbal yoghurt fortified with 3 mL utazi leaf extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leaf extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; AV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. N.D = Not detected. Source: Authors, 2023.

3.7 Sensory scores of herbal yoghurts flavored with utazi leaf extract/aloe vera paste

Table 6 shows the sensory scores of herbal yoghurts flavoured with utazi leave extract/ aloe vera paste.

3.6.1 Colour

The sensory scores for colour of herbal yoghurt varied from 7.10 to 7.85. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YAV2. There were no significant ($p < 0.05$) difference between the control (YC) and sample YUL1, YUL2 and sample YAV1 which has the respective score of 7.55, 7.30 and 7.30. The herbal yoghurt samples had a light green colour and this could be attributed to the chlorophyll present in the plant extract.

3.7.2 Taste

The sensory scores for taste of herbal yoghurt varied from 6.15 to 7.35. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YAV2. There were no significant ($p < 0.05$) difference between the control (YC) and sample YUL1, YUL2 and sample YAV1. The herbal yoghurt samples had a light green colour and this could be attributed to the chlorophyll present in the plant extract. The addition of plant extracts increased bitterness since each plant extract contains several aromatic compounds. However, yogurt may become a good carrier for plant extracts because its presence improved yogurt organoleptic property, such as complemented sourness by increased bitterness, and increased flavour (Jae et al., 2016).

3.7.3 Consistency

The sensory scores for consistency of herbal yoghurt varied from 6.35 to 6.95. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YUL1. There were no significant ($p < 0.05$) difference between the control (YC) and all the herbal yoghurt sample. The herbal yoghurt samples had a slight watery consistency compared to the plain yoghurt. This can be attributed to the increased moisture content of the plant extract.

3.7.4 Appearance

The sensory scores for appearance of herbal yoghurt varied from 6.70 to 7.45. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YUL2. There were no significant ($p < 0.05$) difference between the control (YC) and sample YUL1, YAV1 and sample YAV2. The herbal yoghurt samples had a slight watery consistency compared to the plain yoghurt. This can be attributed to the increased moisture content of the plant extract.

3.7.5 Mouthfeel

The sensory scores for mouthfeel of herbal yoghurt varied from 6.20 to 7.20. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YAV2. There were no significant ($p < 0.05$) difference between the control (YC) and sample YUL2 and YAV1. The mouthfeel which includes the body and texture characteristics of the herbal yoghurt are govern by total solids and moisture content of yogurt. Lower score for mouthfeel for the herbal yoghurt could be due to the concentration of utazi leave extract and aloe vera (Ashwini et al., 2018).

3.7.6 Aroma

The sensory scores for aroma of herbal yoghurt varied from 6.30 to 7.30. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YAV2. There were no significant ($p < 0.05$) difference between the control (YC) and sample YUL2, YAV1 and YAV2. The lower score for aroma of the herbal yoghurt could be because the plant extract contains certain metabolites which might have imparted certain characteristic smell to the herbal yoghurt which the panelist found undesirable in comparison to the plain yogurts.

3.7.7 Aftertaste

The sensory scores for aftertaste of herbal yoghurt varied from 6.30 to 7.30. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YAV2. There were no significant ($p < 0.05$) difference between the control (YC) and sample YUL2, YAV1 and YAV2. The lower score for aroma of the herbal yoghurt could be because the plant extract contains certain metabolites which might have imparted certain characteristic smell to the herbal yoghurt which the panelist found undesirable in comparison to the plain yogurts.

3.7.8 Overall acceptability

The sensory scores for overall acceptability of herbal yoghurt varied from 6.20 to 8.00. The highest score was recorded in sample YC (plain yoghurt) while the lowest score was recorded in sample YAV2. The panelist were not used to the herbal yoghurt containing utazi leave extract/ aloe vera paste and thus rated the plain yoghurt higher than the herbal yoghurts in terms of overall acceptability. However, all the values were in acceptable range.

Table 6. Sensory scores of herbal yoghurts from utazi leaf extract/ale vera paste.

Sample	Colour	Taste	Consistency	Appearance	Mouthfeel	Aroma	Aftertaste	Overall Aceptability
YC	7.85^{a}±0.81	7.35^{a}±1.42	6.95^{a}±1.46	7.45^{a}±0.99	7.20^{a}±1.19	7.30^{a}±1.26	7.15^{a}±1.46	8.00a±0.97
YUL1	7.55^{ab}±0.82	7.10^{a}±1.07	6.35^{a}±0.98	6.95^{ab}±0.82	6.26^{b}±1.16	6.85^{b}±1.18	6.45^{b}±1.05	7.20^{b}±0.83
YUL2	7.30^{ab}±1.17	6.70^{ab}±1.41	6.55^{a}±1.14	6.70^{b}±1.21	6.45^{ab}±1.50	6.65^{ab}±1.38	6.25^{a}±1.33	6.95^{b}±1.05
YAV1	7.30^{ab}±1.17	6.85^{ab}±0.74	6.85^{a}±0.98	7.15^{ab}±0.81	6.50^{ab}±1.00	6.90^{ab}±1.02	6.40^{a}±1.27	7.05^{b}±0.60
YAV2	7.10^{b}±1.02	6.15^{c}±1.46	6.55^{a}±1.19	7.00^{ab}±0.91	6.20^{b}±1.23	6.30^{ab}±1.41	5.00^{b}±1.94	6.20^{c}±1.19

Note: Values are means of 20 panelists ± standar deviation. Means with different superscript in the same column are significantly ($p < 0.05$) different. Key: YC = Plain yoghurt (control); YUL1 = Herbal yoghurt fortified with 3 mL utazi leaf extract; YUL2 = Herbal yoghurt fortified with 6 mL utazi leaf extract; YAV1 = Herbal yoghurt fortified with 3 mL aloe vera paste; AV2 = Herbal yoghurt fortified with 6 mL aloe vera paste. N.D = Not detected. Source: Authors, 2023.

4. Conclusions

The addition of utazi leave extract/aloe vera paste increases the protein ash, fiber, fat, and carbohydrate content of herbal yoghurt. Also, the vitamin and mineral content of the herbal yoghurt were higher compared to plain yoghurt.

The studies also showed that the herbal yoghurt might have the tendency of having longer shelf-life than plain yoghurts due to its low level of total viable count and mould count. It, thus, be concluded that, the addition of extracts of utazi leaves, aloe vera paste to herbal yoghurt production does not only improves the nutritional and health benefits of the consumers but also commercially acceptable.

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6. Auhors' Contributions

Conceptualization, Mbaeyi-Nwaoha, I. E., Methodology, Mbaeyi-Nwaoha, I. E., Software, Mbaeyi-Nwaoha, I. E and Ojochegbe, A. F., Validation, Mbaeyi-Nwaoha, I. E., Formal analysis, Ojochegbe, A. F., Investigation, Ojochegbe, A. F., Resources, Mbaeyi-Nwaoha, I. E and Ojochegbe, A. F., Data curation, Ojochegbe, A. F., Data preparation, Mbaeyi-Nwaoha, I. E and Ojochegbe, A. F., Writing original draft preparation, Mbaeyi-Nwaoha, I. E and Ojochegbe, A. F., Writing- review and editing, Nnamani, C. J., Visualization, Mbaeyi-Nwaoha, I. E and Ojochegbe, A. F., Supervision, Mbaeyi-Nwaoha, I. E., Project Administration, Mbaeyi-Nwaoha, I. E and Ojochegbe, A. F., Funding Acquisition, Ojochegbe, A. F.

7. Conflicts of Interest

No conflicts of interest.

8. Ethics Approval

Not applicable.

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