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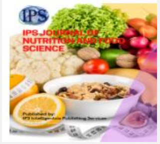

# Nutritional and Antioxidant Properties of Yoghurt Enriched with Pineapple and Orange Pomace

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**Abstract**

The present study aimed to evaluate the physiochemical, and nutritional properties of the yoghurt enriched with pineapple and orange pomace. Five yoghurt samples were prepared using skimmed milk, orange pomace, and pineapple pomace blends. The physicochemical properties (pH, total titratable acid, free fatty acidity, total soluble solid, and brix), anti-nutrient properties (saponins, oxalate, phytate, tannins, and alkaloids), and antioxidant properties [ferric reducing antioxidant properties (FRAP), 2, 2'-azino-bis (3-ethylbenthiazoline-6-sulphonic acid (ABTS), 1, 1- diphenyl-2-picryhydrazyl (DPPH), phenol and iron chelate ($Fe^{2+}$) of the samples were evaluated. The study showed that pineapple and orange pomaces affected the pH and viscosity of the samples. The mean and standard deviation of the samples were determined and a One-Way Analysis of Variance (ANOVA). There were significant increase ($p \leq 0.05$) in the free fatty acid (9.10-12.00%), total soluble solid (6.30 10.50%), total titratable acid (8.50-14.93%), and brix (11.50-17.00%) compared with the control. The anti-nutritional factors were within acceptable standards and sample YOB (75.04% Skimmed Yoghurt, 22.65% Pineapple Pomace and 2.87% Orange Pomace) had the best antinutritional and antioxidants properties. Therefore, Pineapple and Orange pomace can be used as a functional ingredient for the development of Skimmed Milk yoghurt.

***Keywords:*** *Yoghurt, pomace, physicochemical, nutritional properties, functional drink*

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## Introduction

Yoghurt is formed by fermenting milk with *Streptococcus thermophilus* and *Lactobacillus delbrueckii subsp bulgaricus*, resulting in its distinct flavor and texture (Arijit *et al*., 2020). According to Rodriguez *et al.* (2006), adding pomace powder to yoghurt enhances its physicochemical properties, nutritional qualities, and functional benefits such as swelling, water retention, emulsification, and textural enhancement. Enriched yogurt with these advantages can be a healthier choice for consumers compared to conventional yogurts (Olabiran *et al*., 2023: Noreen *et al*., 2019).

Pomaces are solid waste products of fruits rich in dietary fiber, they are pulpy residue remaining after extracting the juice of a fruit (Hussein *et al*., 2015). They can be obtained from fruits after processing for juice, pulps, jams, and jellies (Awolu *et al*., 2016). Recommended globally for its health benefits pomace fiber possesses unique functional properties modifying the texture, taste, and shelf life of food products, such as water-holding capacity, gel-forming ability, fat mimetic properties, thickening characteristics, and anti-staling benefits (Charoenthaikij *et al*., 2016: Sabanis *et al*., 2009). Citrus pomaces provide a rich source of bioactive ingredients with excellent technological and nutritional properties (Awolu *et al.*, 2020). Their affordability and versatility make them ideal components or additives in food products and are also cost-effective (Sánchez *et al*., 2017). Pineapple (*Ananas comosus*) is mainly consumed fresh or processed as canned fruit the increasing production of processed pineapple and citrus juice results in significant waste and by-products. Utilizing by-products from fruit and vegetable processing is a crucial and challenging task globally (Homayouni *et al*., 2013: Tran, 2006). Pineapple pomace contains high levels of dietary fiber, vitamins, and minerals (Wang *et al*., 2002) Dietary fiber is mainly incorporated into cereal-based products, particularly bakery products, meat and milk products (Dhingra *et al*.,

2012). Several authors have reported enriching fibers from fruit and vegetable wastes in food products for human consumption (Nagarajaiah and Prakash, 2016). Studies have explored the incorporation of pineapple pomace in sausages and as fiber enrichment in extruded products (Selani *et al*., 2014). Orange peel powder has been utilized as a source of dietary fiber in cake production (Montalvo-González *et al*., 2018); Zaker *et al*., 2017). Developing beef patties using pumpkin pulp has been researched and preparing high-fiber biscuits from Chinese olive pomace has been reported (Serdaroğlu *et al*., 2018: Lin *et al*., 2017). Fiber-enriched wheat bread has also been developed (Chareonthaikij *et al*., 2016). Studies have indicated that adding pineapple pomace to the diet of diabetic rats improved glucose metabolism and reduced inflammation (Hou *et al*., 2020). Another study found that pineapple pomace may help reduce cholesterol levels and improve liver function in mice (Yun *et al*., 2021).
This study aims to utilize pineapple and orange pomace to enhance yogurt, improving its physicochemical, nutritional, and functional properties.

## Materials and Methods

Skimmed milk and the starter culture were purchased from a Supermarket in Akure, Ondo State, Nigeria. Orange and Pineapple fruits were obtained at Oja Oba market, Akure, Ondo State, Nigeria. The fruit samples were authenticated at the Department of Food Science and Technology, Federal University of Technology, Akure, Ondo State, Nigeria. The reagents used for the analyses were of analytical grade.

### Preparation of Orange Pomace

Orange (*Citrus sinensis*) pomaces were prepared in the Food Processing Laboratory, Department of Food Science and Technology, Federal University of Technology, Akure, Ondo State, Nigeria. Deseeded orange pomace was oven-dried (Model 320, Gallenkamp, England) at 80 °C for 12 h and subsequently milled (Asiko Attrition Mill, Lagos, Nigeria; Serial No A11). The pomace powder was sieved using a 500 µm aperture sieve and packed in an air-tight container until used (Arijit *et al*., 2020).

### Preparation of Pineapple Pomace

The pineapple was washed, peeled, and oven-dried (Model 320, Gallenkamp, England) at 80 °C for 12 h and milled (Asiko Attrition Mill, Lagos, Nigeria; Serial No A11). The pineapple pomace powder was sieved using a 500 µm aperture sieve and packed in an air-tight container for further analysis (Awolu *et al*., 2019).

### Preparation of Processed Yoghurt made with Pomace

Yoghurt was produced according to the method of Awolu and Olofinale (2016) with slight modifications. Five samples of yoghurts were produced using skimmed milk, yoghurt enriched with pineapple, and orange pomace. The Yoghurts were coded YOA, YOB, YOC, YOD and YOE according to their formulation in Table 1. Dried powder milk (250 g) was reconstituted to make up 500 mL using sterile water. The milk was heated to 40 °C. The samples were pasteurized at 90 °C for 15 min. The mixture was cooled to 43 °C and inoculated with a commercial yoghurt starter culture (pure culture of mixed strain of *Lactobacillus bulgaricus* and *Streptococcus thermophillus*). The mixture was stirred for complete homogenization. The samples were incubated at about 44 °C for 7 h until curds were formed at pH 4.5. The curds were broken with a hand stirrer to form a smooth homogenous product, and stored in a refrigerator at a temperature of 4 °C for 24 h preparatory for sensory evaluation.

**Table 1:** Formulation of yoghurt samples

| Labels | Skimmed Yoghurt (%) | Pineapple Pomace (%) | Orange Pomace (%) |
|---|---|---|---|
| YOA | 100 | 0 | 0 |
| YOB | 75.04 | 22.16 | 2.87 |
| YOC | 84.32 | 13.65 | 3.03 |
| YOD | 78.82 | 16.32 | 4.88 |
| YOE | 78.05 | 16.31 | 5.64 |

*YOA= 100% Skimmed Yoghurt*
*YOB=75.04% Skimmed Yoghurt, 22.65% Pineapple Pomace and 2.87% Orange Pomace*
*YOC= 84.32% Skimmed Yoghurt, 13.65% Pineapple Pomace and 3.03% Orange Pomace*
*YOD= 78.82% Skimmed Yoghurt, 16.31% Pineapple Pomace and 4.88% Orange Pomace*
*YOE= 78.0 % Skimmed Yoghurt, 16.31% Pineapple Pomace and 5.64% Orange Pomace*

### Determination of pH and Total Titratable Acid of Yoghurt

The pH was measured using a calibrated pH meter (Ashogbon and Akinayo, 2014) and the total titratable acid (TTA) content of the yoghurt was determined according to the method of AOAC (2005).

### Determination of Total Soluble Solids and Brix Determination

The total soluble solids of the yoghurt samples were measured using a digital refractometer (Hanna Instruments 96801 Digital Refractometer, USA) at 25 ºC and expressed in ºBrix. The sugar content was measured at 20 °C with an eclipse refractometer and the result was expressed in °Brix (%sucrose) (Zhang and McCarthy, 2013).

### Determination of Free Fatty Acids

95% neutralized isopropanol and phenolphthalein indicator were added to the liquid fat sample. The sample was titrated with NaOH, and each sample's percent free fatty acid was calculated. The color of the sample appeared pink and persisted for 30 s. The volume of sodium hydroxide used was recorded (Pike and O'Keefe, 2017).

### Determination of Viscosity

The measurement of viscosity was conducted using a rotational viscometer (RION, Tokyo Japan) according to the method of AOAC (2005). 100 mL of sample was loaded into the test cell. The rotor was dipped into the sample and allowed to spin until the needle scale pointer stopped at a certain scale.

**Determination of Antioxidant Properties**

The ferric reducing antioxidant property of the extract was determined. 0.25 ML of the sample extract was mixed with 0.25 ML of 200 mM of Sodium phosphate buffer pH 6.6 and 0.25 ML of 1% KFC. The mixture was incubated at 50 ºC for 20 min, thereafter 0.25 ML of 10% TCA was also added and centrifuged at 2000 x g force for 10 min. Exactly 1 mL of the supernatant was mixed with 1mL of distilled water and 0.1% $FeCl_3$, and the absorbance was measured at 700 nm (Pulido *et al*., 2000).

The free radical scavenging ability of the extract against DPPH (1, 1- diphenyl-2 picryhydrazyl) was determined using the method of Gyamfi *et al*. (1999). About 1 ML of the extract was mixed with 1 ML of the 0.4 mM methanolic solution of the DPPH the mixture was left in the dark for 30 min before measuring the absorbance at 516 nm.

The ability of the extract to chelate $Fe^{2+}$ was determined using a modified method. Briefly, 150 mM $FeSO_4$ was added to a reaction- mixture containing 168 mL of 0.1 M Tris-HCl, pH 7.4, 218 mL saline, and extract, and the volume was made up to 1 mL with distilled water. The reaction mixture was incubated for 5 min, before the addition of 13 mL of 1, 10-phenantroline; the absorbance was read at 510 nm (Puntel *et al*., 2005).

The 2, 2'-azino-bis (3-ethylbenthiazoline-6-sulphonic acid) (ABTS) scavenging ability of the extract was determined according to the method described by Re *et al*., (1999). The ABTS was generated by reacting a 7 mM ABTS aqueous solution with K2S2O8 (2.45 mM/l, final conc.) in the dark for 16 h, while the absorbance at 734 nm was adjusted to 0.700 with ethanol. 0.2 mL of the appropriate dilution of the extract was then added to 2.0 ML of ABTS solution and the absorbance was read at 732 nm after 15 min.

The TROLOX equivalent antioxidant capacity was subsequently calculated. The total phenolic content was measured using the Folin-Ciocalteu reagent and was reported in milligrams of Gallic Acid Equivalents (GAE) per 100 gm (Zheng and Wang, 2001).

**Determination of Antinutritional Qualities of Yoghurt Samples**

Tannin determination: 0.2 g of finely ground sample was weighed into a 50 mL sample bottle, and 10 mL of 70% aqueous acetone was added and properly covered. The bottle was put in an ice bath shaker and shaken for 2 h at 30 ºC. Each solution was then centrifuged and the supernatant was stored in ice. Standard tannin acid solutions were prepared. Half a mL (0.5 mL) of Folin ciocateau reagent was added into the sample. The standard aliquots and 2.5 mL of 20% $Na_2CO_3$ was added into the solution. The votexed solution was incubated at room temperature for 40 min, and the absorbance was read at 725 nm against a reagent blank concentration of the same solution from a standard tannic (Makkar and Goodchild. 1996).

Phytate was determined by the method of Wheeler and Ferrel's (1971). The samples were soaked for three hours in a solution of 100 mL 2% HCl and then filtered through a No 1 Whatman filter paper. From the filtrate, 25 mL was taken and poured into a conical flask, and 5 mL was added to 0.3% ammonium thiocyanate solution which served as an indicator. The required acidity was achieved by blending 53.5% distilled water with the solution. This mixture was titrated against 0.00566 g/ml of iron (iii) chloride solution containing 0.00195 g of iron per milliliter until a brownish-yellow colour which remained constant for 5 mins was formed.

The oxalate content was determined using the method of Baker (1952). One gram (1 g) of the sample was soaked in 75 mL of 1.5 N $H_2SO_4$ solution for an hour, and filtered through a No 1 Whatman filter. Exactly 25 mL of the filtrate was later transferred into a conical flask and titrated with 0.1m KMnO4 at temperatures between 80-90 °C until a pink colour persisted for 15 sec was obtained.

The spectrophotometric method of Brunner (1994) was used to determine the saponin content. About 2 g of the sample was weighed into a 250 mL beaker while 100 mL of Isobutyl alcohol was added. A shaker was used to shake the mixture for 5 h to ensure uniform mixing. The mixture was filtered with No 1 Whatman filter paper into a 100 mL beaker containing 20 mL of 40% saturated magnesium carbonate solution (MgCo3). The mixture obtained was filtered through No 1 Whatman filter paper to get a clean colourless solution. It was allowed to stand for 30 min for the colour to develop. The absorbance was read against the blank at 380nm.

Five gram (5g) of the sample was weighed into a 250 mL beaker and 200 mL of 10% acetic acid in ethanol was added and allowed to stand for 4 min to determine alkaloid. This was filtered and the extract was concentrated in 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 was collected, washed with dilute ammonium hydroxide, and filtered. The residue (alkaloid) was dried and weighed (Harbone, 1973).

**Statistical Analysis**

Statistical Package for Social Science version 21 (IBM SPSS Statistics, US) was used to examine the results statistically. The mean and standard deviation of the samples were determined and a One-Way Analysis of Variance (ANOVA) was done for comparison. However, the statistically significant difference of all samples analyzed was performed $p \leq 0.05$ (SPSS, 2011).

## Results and Discussion

**Physicochemical Composition of the Yoghurt**

All samples showed an acidic pH with a range of 3.93 to 4.50 as shown in Table 2 below. The acidic pH range observed in the samples (3.94 – 4.22) aligns with the report of Arijit *et al.*, (2020), that the acidity of yoghurt increased with an increase in the concentration of the orange pomace powder. It is believed that the fermentation process and the actions of lactic acid bacteria influence the pH levels, resulting in improved acidity (Aderinola and Adeniran, 2015).

When supplemented with orange and pineapple pomace, the acidity of the yogurt was further enhanced. The lactic acid bacteria were found to be responsible for converting lactose in the yogurt samples into lactic acid, thereby increasing the acidity. The pH decrease rate of 3.39% in sample YOB contained a higher percentage of sugar from orange and pineapple, as indicated by the Brix value. Previous studies involving the use of wine grape pomace in yogurt during cold storage indicated that pomace increases the pH value of wine (Tseng and Zhao, 2013). Similar results were also achieved when yogurt was fortified with dried apple peel powder by Zhou (2018). The pH values obtained in the present study agreed with FDA specifications for yogurt acidity of 4.6 or lower (Srivastava *et al.*, 2015). Samples YOB and YOE, which contained pomace, exhibited significantly higher Brix values compared to the control yogurt (YOA). Fruits naturally contain sugars, such as fructose and glucose, which are released from the pomace when added to yogurt. As a result, the overall sugar content of the yogurt samples.

The viscosity of the yogurts ranged between 3.78 and 4.39 Pa.s. While differences in viscosity may be attributed to the type of raw material used, the gradual decline in viscosity in yogurts with pomaces could be due to the liquefaction of sugar during fermentation. Similar trends were reported in yogurt fortified with dried apple peel powder (Zhou 2018). The total soluble solid (TSS) results revealed that sample YOB had the highest solubility. Generally, adding pomace to the samples conferred higher TSS values than the control yogurt (YOA). The total solids content in the yogurt indicates the amount of sugar and ash present. The fermentation process of lactic acid bacteria resulted in the production of metabolites in the form of lactic acid, thus contributing to the total dissolved solids (Ani *et al.*, 2018). The free fatty acid content in the study ranged from 6.30 to 12.00%. This value was approximately two times higher than in a previous study (Noreen *et al.*, 2019). It is believed that the high level of acetic acid in the present study may have led to this difference. Furthermore, the metabolism of sugar and amino acids, as well as the type of culture used, could also increase the fatty acid content in the yogurt. The total titratable acidity of the yogurt in this study increased with the addition of pomaces. It is believed that the fermentation of lactose by lactic acid bacteria, as well as the presence of citric acid and ascorbic acid in orange pomace, contributed to the increased titratable acidity (Aderinola and Adeniran 2015).

### Antinutrient Properties of Yoghurt Made with Orange and Pineapple Pomace

The result of the antinutrient properties of yoghurt made with orange and pineapple pomace is presented in Table 3.

**Table 2:** Physicochemical composition of yoghurt yoghurt made with orange and pineapple pomace

| Samples | pH | BRIX (%) | TTA (%) | TSS (%) | FFA (%) | Viscosity (Pa.s) |
|---|---|---|---|---|---|---|
| YOA | 4.50±0.01[a] | 10.50±0.70 [c] | 6.20±82 [c] | 6.00±1.41 [d] | 6.30±0.10 [c] | 4.39±0.00 [a] |
| YOB | 3.39±0.04[a] | 17.00±0.00 [a] | 8.50±82 [b c] | 10.50±0.64 [a] | 10.05±63 [b] | 3.78±0.25 [c] |
| YOC | 4.40±0.13[a] | 14.00 ±0.00[b] | 10.99±92 [b] | 8.80±1.13 [ab] | 9.10±0.70 [b] | 4.16±0.06 [ab] |
| YOD | 4.30±0.13[a] | 11.50±0.70 [c] | 14.93±1.56 [a] | 6.30 ±0.01 [c] | 10.70±4.25 [ab] | 4.03±0.04 [bc] |
| YOE | 4.28±0.08[a] | 11.50±0.70 [c] | 11.63±1.60 [b] | 7.13±2.61 [b] | 12.00±0.56 [a] | 4.04±0.42 [bc] |

*Results are mean values of duplicate determination ± standard deviation. Mean values within the same column having the same letter are not significantly different at* $p \leq 0.05$.

**Table 3:** Results of anti-nutrient content of yoghurt samples

| Samples | Saponins (mg/100g) | Oxalate (mg/100g) | Phytate (mg/mL) | Tannins (mg/mL) | Alkaloids (mg/g) |
|---|---|---|---|---|---|
| YOA | 10.10±0.39 [d] | 0.18±0.00 [e] | 2.06±0.58 [d] | 6.90±0.40 [c] | 5.18±0.50 [d] |
| YOB | 18.90±0.51 [a] | 1.94±0.63 [a] | 9.50±0.58 [a] | 17.85±1.37 [a] | 6.70±0.35 [a] |
| YOC | 15.36±0.39 [b] | 1.67±0.63 [b] | 6.53±0.58 [b] | 17.98±0.85 [a] | 5.61±0.50 [b] |
| YOD | 13.98±0.13 [b] | 0.54±0.00 [c] | 4.94±0.00 [c] | 12.47±0.34 [b] | 5.55±0.01 [bc] |
| YOE | 11.63±1.02 [c] | 0.40±0.06 [d] | 4.72±0.39 [c] | 11.92±2.56 [b] | 5.46±0.01 [b] |

*Results are mean values of duplicate determination ± standard deviation. Mean values within the same column having the same letter are not significantly different at* $p \leq 0.05$.

The presence of pomaces in the yogurt is crucial for assessing the antinutrient content. In our samples, sample YOB, which contained the highest level of pineapple pomace exhibited the highest antinutrient levels. The study found that the oxalate content ranged from 0.18 to 1.94 mg/100g. The significant oxalate content in the samples may be due to the low oxalate content in the animals' food sources. A study by Ani *et al*., (2018) reported lower oxalate values ranging from 0.16 to 0.62 mg/100g in yogurt prepared from moringa seed milk, soybean, and Bambara nut. The phytic acid content of the yoghurt in this study ranged from 2.06 to 9.50 mg/100g. Interestingly, the phytic acid content is comparable to the 3.28 to 11.70 mg/100g range reported by Zaker *et al.*, (2016), as well as the values reported for yogurt prepared from soybeans, Bambara nut and moringa seed milk (Ani *et al.*, 2018), which varied from 2.37 to 8.78 mg/100g. Despite being an antinutrient, phytate has beneficial effects, such as lowering blood glucose levels, plasma cholesterol, and triacylglycerol levels (Ogodo *et al.*, 2019). Studies have shown that fermentation reduces the amount of anti-nutritional factors (Etsuyankpa *et al.*, 2015). The saponin content in the study ranged from 10.10 to 18.90 mg/100g higher than the range 0.86 to 3.75 mg/100g saponin content obtained from yogurt made from moringa and bambara nut milk (Ani *et al.*, 2018). The high saponin content observed in our study may be a result of the incorporation of pomaces. Saponins have been reported to have anticancer properties, as well as hypocholesterolemic effects (Man *et al.*, 2010).

**Antioxidant Properties of Yoghurt made with Orange and Pineapple Pomace**

The antioxidant properties of skimmed yoghurt with orange and pineapple pomace are presented in Table 4. Probiotics in yogurt, such as *Lactobacillus acidophilus* and *Bifidobacterium lactis* enhance antioxidant activities, which can be beneficial for individuals with Type 2 Diabetes Mellitus (Simwaka *et al*., 2017). Yoghurt samples with pomace exhibited higher overall antioxidant activities compared to the sample without pomace, except for the ABTS test, where there were no significant ($p< 0.05$) differences among all the samples, including those with pomace. Additionally, sample YOB, which had the highest pineapple pomace incorporation, showed the best overall antioxidant activities. Pineapples are known to contain various bioactive compounds (Huang *et al*. 2011), which could contribute to the high phenolics content observed in samples YOB (0.10 mg GAE/100 g) and YOC (0.11 mg GAE/100 g). It is known that the reducing power of $Fe^{2+}$ is associated with antioxidant activity, a relationship that has been established with numerous bioactive compounds isolated from natural plants (Siddhurajua *et al*., 2017). There was a significant increase in the $Fe^{2+}$ levels in yogurt containing pineapple and orange pomace, ranging from 21.75-29.62, compared to 16.69 in 100% skimmed yogurt without pomace. The high antioxidant activity is attributed to the radical absorbing effect of the bioactive compounds in the enriched yogurt. Pineapple pomace has also been shown to have antioxidant properties and may help protect against oxidative stress (Hilkal *et al*., 2021). In general, adding blended pomace to yogurt led to increased antioxidant activities.

**Table 4:** Antioxidant properties of the yoghurt

| Samples | Phenol (mg GAE/g) | FRAP (mg/g) | DPPH (%) | ABTS (mMol/g) | $Fe^{2+}$ |
|---|---|---|---|---|---|
| YOA | $0.07±0.00^{c}$ | $8.84±0.73^{d}$ | $57.26±0.36^{c}$ | $0.01±0.00^{a}$ | $16.69±0.84^{c}$ |
| YOB | $0.10±0.02^{ab}$ | $18.75±0.80^{a}$ | $68.26±0.25^{a}$ | $0.02±0.00^{a}$ | $29.62±2.42^{a}$ |
| YOC | $0.11±0.00^{a}$ | $17.75±1.35^{b}$ | $61.86±0.36^{ab}$ | $0.01±0.00^{a}$ | $24.40±2.54^{ab}$ |
| YOD | $0.08±0.02^{c}$ | $12.30±0.36^{c}$ | $59.61±0.10^{b}$ | $0.01±0.00^{a}$ | $21.75±2.67^{bc}$ |
| YOE | $0.08±0.00^{c}$ | $12.14±0.18^{c}$ | $59.55±0.88^{b}$ | $0.02±0.00^{a}$ | $22.52±1.09^{b}$ |

*Results are mean values of duplicate determination ± standard deviation. Mean values within the same column having the same letter are not significantly different at* $p≤0.05$.

## Conclusion

The pineapple and orange pomace affect the physicochemical properties of the yoghurt by reducing pH and Viscosity while the brix, total titratable acidity, total soluble solids, and free fatty acids were increased. The yoghurts fortified with pomace had a positive effect on nutritional properties compared to the control but sample YOB showed the strongest desirable antinutrient and antioxidant properties. The addition of pineapple and orange pomace to yoghurt reduces its viscosity. Therefore, orange and pineapple pomace can serve as an industrial by product in yoghurt and can successfully be utilized for the development of fiber-enriched yoghurt with improved health benefits.

## Declarations

**Competing Interest**

The authors declare no competing interest.

**Authors' Contributions**

All listed authors contributed equally to the research process, literature writing, review and editing of the article.

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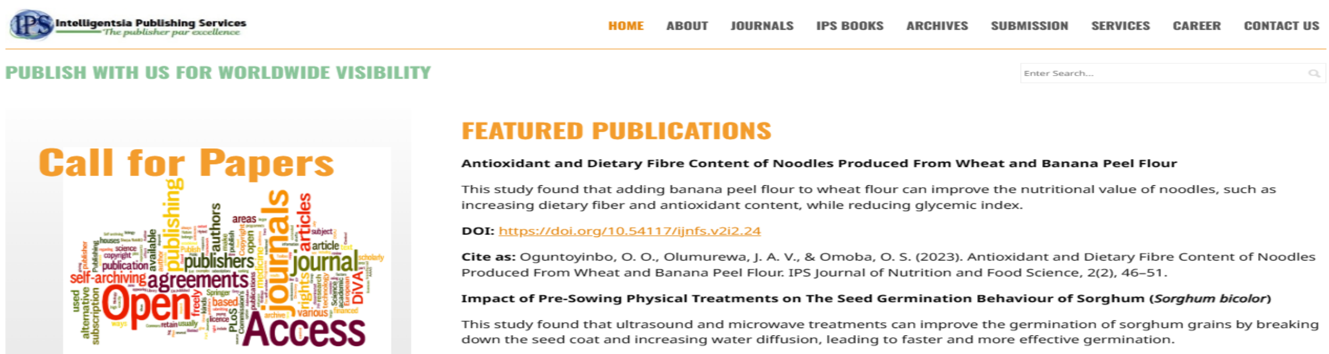




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