Research Journal of Food Science and Quality Control (RJFSQC) E-ISSN 2756-5483
P-ISSN 2695-2459 Vol 10. No. 4 2024 www.iiardjournals.org Online Version

Physico-chemical Properties and Sensory Evaluation of Ogi Flour Supplemented with Date (*Phoenix dactylifera*) Powder

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DOI: 10.56201/rjfsqc.v10.no4.2024.pg10.23

Abstract
The physicochemical and sensory properties of ogi flour supplemented with date powder was evaluated. The maize was washed, steeped, wet-milled, sieved, fermented, dried, milled and sieved to achieve fine ogi flour. The date fruits were sorted and washed, pitted, sliced, oven dried, at 65^0C overnight, milled and sieved to obtain date powder. The ogi flour was supplemented with date powder using the ratio (100:0, 90:10, 80:20, 70:30) while the 100% ogi flour was used as the control. Proximate composition of the blends ranged from 3.20-5.66% moisture, 0.30-1.12% for ash, 5.17-6.36% fat, 4.81-6.51% for protein, 2.07-2.50% fibre, 79.03-83.18% carbohydrate, 2.11-3.33% total sugar and 397.66-405.16 kcal. Date substitution led to a significant increase ($p<0.05$) in ash, fibre and the total sugar content while moisture, protein fat decreased. There was no significant ($p>0.05$) increase in the carbohydrate content. The functional properties ranged from 0.93-1.14g/g for water absorption capacity, 12.45-28.49% solubility index, 1.94-2.00gml for bulk density,10.47-8.15g/g swelling power, all samples gelled at 2%. The sensory properties include properties that ranged from 5.60-6.90 for aroma, 5.45-8.35 colour, 5.25-6.65, 5.70-6.85 for sourness, 5.40-6.95 taste and overall acceptability of 1.36-5.26. There was no significant difference ($p>0.05$) in aroma, mouth feel, sourness, and taste but however, substitution with date improved the aroma, taste and mouth feel. This study showed that date powder can be used to complement ogi flour. The proportion of (70% ogi flour and 30% date powder can be used as sweetener and substituted with ogi flour.

Keywords: *Ogi Flour, Date Powder, Physico-Chemical Properties, Sensory Evaluation*

1. INTRODUCTION

Ogi is an important staple fermented cereal gruel or liquid porridge produced from either maize, sorghum or millet grains (Kiin-Kabari *et al*., 2018). In many parts of Africa and Nigeria, ogi is alled "pap" and predominantly used as infant weaning food, as well as breakfast meal for many adults (Ogodo *et al*., 2015). Ogi is seen as one of the cheapest and popular foods. It is a meal to enhance breakfast milk production for nursing mothers and recovery diet for the sick (Afolayan *et al*., 2010). The colour of ogi depends on the type of cereal used for its production. The traditional production process involves soaking of maize grains in cold water for 1-3 days after which the water is decanted (Ohehen and Ikenebomah, 2017). The soaked grains are wet milled and sieved using muslin cloth and the filtrate is fermented for 2-3 days to yield wet ogi, which is a sour,

starchy sediment (Ohehen and Ikenebomah, 2007). During the processing of ogi, nutrients such as proteins and minerals are lost which reduces the nutritional quality of the final product (Afolabi *et al*., 2015). This therefore results in the reduction of net protein utilization, protein energy ratio and biological values (Aminigo *et al*., 2004).

Date palm fruit (*Phoenix dactylifera*) locally known as "debino" in Hausa language originates from the family of *Aracaceae* (Alshabib and Marahall, 2003). It is known for its sugary taste. The fruit is a drupe in which the outer fleshy part consists of the pulp and the pericarp surrounding a shell of hard endocarp with the seed inside (Farheena *et al*., 2015). According to Dada *et al*. (2012), date palm fruit contains more than 70% sugar mainly glucose and fructose. It is high in energy value, making it an ideal replacement for sugar (Peter-Ikechukwu *et al*., 2020). The chemical composition of dates can vary depending on cultivar, soil conditions, agronomic practices and the ripening stage (Al-Kahtani & Soliman, 2012). Date fruit has been found to contain carbohydrates (total sugars 44%-88%), fat (0.2%-0.4%), proteins (2.3%-5.6%), dietary fibre (6.4%-11.5%), vitamins and minerals. The level of sugar changes during ripening stages for example, during the Khalal stage, nearly all (80% to 85%) of sugar is sucrose. Sucrose is hydrolyzed into reduced sugars as glucose and fructose as ripening progresses (Habib *et al*., 2014). Date fruit also contains some vitamins (A, B1, B2, B3, B5 and Vitamin C). Vitamin A in dates are known for their antioxidant properties which are important for good vision (Siddiq and Grieby, 2014). Date seeds are reported to contain relatively high amounts of protein, 5.1% and fat, 9.0% compared to the date flesh (Ardekan*i et al*., 2010).

Dates have a consortium of nutrients that are prolific with high carbohydrate content mainly in the form of sugars, a rich dietary fibre content, an abundance of vitamins and minerals, and, ultimately, high levels of both antioxidant activity and phenolic content. The sweet–savoury sensation derived from dates is attributed to the enormous abundance of natural sugars that are sucrose, glucose and fructose. The chemical composition of dates has been linked to many important health benefits ranging from the treatment of cardiovascular disease to the treatment of stomach disorders (Vayalil, 2012). Dates help protect against many chronic diseases including cancer and heart disease. In addition to vitamins and minerals, date is rich in natural fibre (Arshad *et al*., 2019). Studies have reported that date fruit extract is useful in reducing blood cholesterol levels (Ali *et al*., 2012). Date palm fruit can be used as a substitute to sugar in bakery and confectionery products. Sugar is a major ingredient used in the production of cookies. The nutritional composition of dates and its use as a substitute to sweeten food products therefore qualifies it to be used as in the fortification and sweetening of ogi.

In an attempt to improve on the nutrient content of ogi, several studies have been carried out on the fortification of ogi with fresh crayfish (Ajanaku *et al*., 2013), pigeon pea (Okafor *et al*., 2018), okra seed meal (Aminigo *et al*., 2004), and groundnut seed (Ajanaku *et al*., 2012). Results obtained showed an improvement in the protein content of the ogi; however the acceptability of the fortified ogi samples decreased. Date fruit with it sugar content and high nutritional composition can be used as a good alternative to fortify ogi since most of the nutrients contents such as protein and mineral are lost during the processing of ogi. Ajanaku *et al*. (2012) reported that one of the strategies to enhance the cereal meal such as ogi is by supplementation with legumes and fruits that are rich in vitamins, protein and minerals. The combination of maize gruel (ogi) with date

palm flour is culturally and biologically critical since the nutritional value and acceptability of ogi will be significantly enhanced by the addition of dates as it is a source of protein and natural sugar.

2. MATERIALS AND METHOD

2.1. Materials

Maize (*Zea mays*) and date palm fruit (*Phoenix dactylifera*) were purchased from Mile 3 Market, Diobu, Port Harcourt, Rivers state.

2.2. Preparation of Ogi flour

Ogi flour was produced using the method of (Kiin-Kabari *et al*., 2018). The maize grains were cleaned and sorted by removing the pest-infested grains and discolored ones. It was then steeped for 72hrs at room temperature and the steep water was decanted while the fermented grain was washed with portable water and wet-milled. It was then wet-sieved and the slurry could ferment for 24 h. it was afterwards decanted, dried at 70^{o}C for 4 h and milled using hammer mill. The fermented maize flour was then sieved to obtain a finer particle (630um mesh size) and packaged in air-tight containers prior to analysis. The production chart is presented on Figure 1.

2.3. Preparation of Date powder

The date powder was produced using the method described by (Barreveld, 1993; Algarni, 2020). The seeds were soaked in water for 72 hours, washed to get rid of any adhering flesh, air-dried for one day, then dried in a medium heat oven at 50°C for one hour and grounded into a coarse powder using a hammer mill. Then again ground into a fine powder using a commercial home milling machine to produce fine date seeds powder which was then kept in an airtight container (Barreveld, 1993; Algarni, 2020).

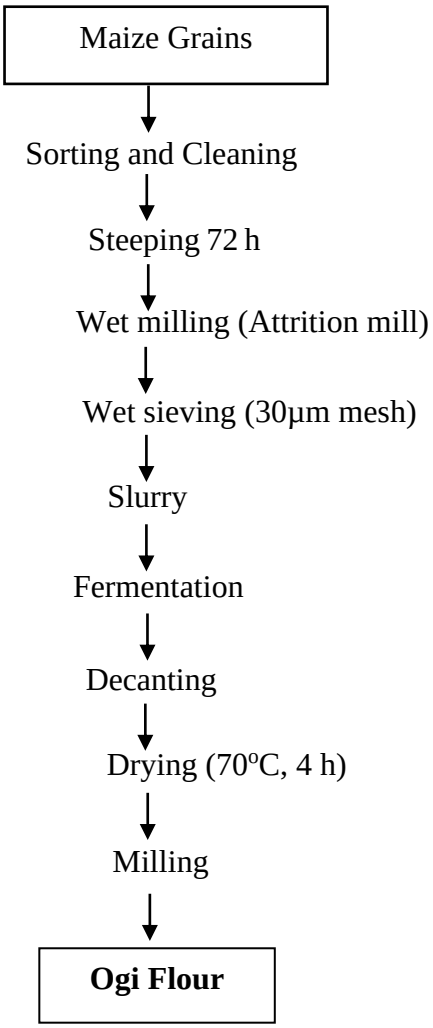

Fig. 3.1: Production of Fermented Maize Flour

Source: (Kiin-Kabari *et al*., 2018). Modified.

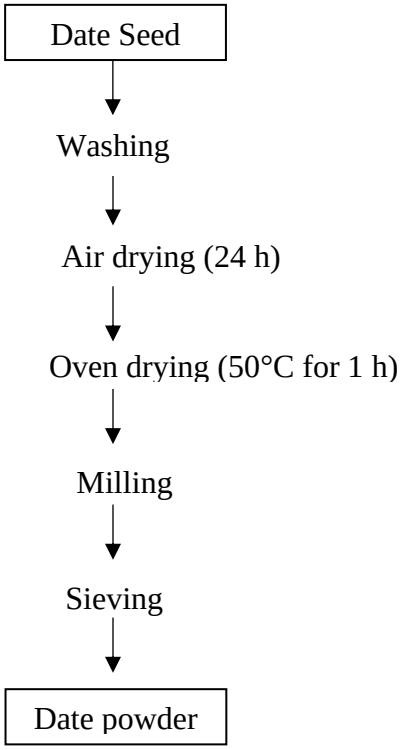

Fig. 2: Production of Date powder
Source: Barreveld, 1993; Algarni, 2020).

2.4. Proximate Analysis

Proximate composition of the samples was determined following established procedures (AOAC, 2012). Moisture content was assessed by drying 5 g of milled samples in an air oven at 130°C for 1 hour using the NAAFCO BS Oven (model: OVH-102). Ash content was gravimetrically measured in a muffle furnace (Sanyo Gallenkamp, Weiss Technik, West Midlands, UK) at 550°C for 24 hours. To determine protein content, 0.5 g of material was exhaustively extracted with petroleum ether in a micro Soxhlet extraction apparatus (Gerhardt, Bonn, Germany). The Kjeldahl method, involving distillation and titration with a factor of 5.7, was used for protein determination. Carbohydrate content was calculated by difference.

2.5. Functional Properties

For the determination of functional properties, the method of Onwuka (2005), was used for the determination of Water absorption capacity. Bulk density and Swelling power were determined by the method described by Ukpabi and Ndimele (1990). Least gelation concentration (LGC) of the flour blends was determined using the modified method of Coffman and Garcia (1977). Solubility index were determined as described by Takashi and Sieb (1988) using SPECTRA, UK (Merlin 503) centrifuge.

2.6. Sensory Analysis

Sensory evaluation of the ogi will be carried out using the method described by Giami and Barber (2004). A twenty-member untrained panelist consisting of students of the Rivers State University, Port Harcourt, Nigeria was used for sensory evaluation. The ogi will be served on a white disposable flat plates and bottled water also served for cleaning the mouth in-between each sample to prevent the transfer of sensory attributes from one sample to the other. Sensory attributes evaluated were; colour, taste, aroma, sourness, and overall Acceptability using a 9-point hedonic scale ranging from 1 to 9; where 1 represent dislike extremely and 9 like extremely as described by Iwe (2010).

2.7. Statistical Analysis

All collected data were subjected to analysis of Variance (ANOVA) using SPSS (Version 23, 2007). Duncan multiple range test was used to separate the differences in the mean scores.

3.0 Results and Discussion

3.1 Proximate composition of ogi from maize flour and date flour blends

The analysis of the proximate composition of the *Ogi* ranged from 3.20% in sample B (10% date powder) to 5.66% in sample A (100% maize flour), this showed a reduction in the moisture content. This results agreed with Peter-Ikechukwu *et al.,* (2020) report that high incorporation of date palm binds water due to high sugar content. The moisture content of the composite flours when compared with the control A (100% maize flour), showed that higher substitution of date palm reduced the moisture content of the flour blends. High moisture encourages the development of contaminating microorganisms, whose growth and activities cause spoilage in foods (Okafor and Ugwu, 2014).
The low moisture content is an indication of better shelf life and storability of the product.

The ash content ranged between 0.30% in sample A (100% maize flour) and 0.70% for sample C with (20% date powder). There was a significant ($p<0.05$) increase in the ash contents of samples B (10% date powder), C (20% date powder) and D (30% date powder) blends with the addition of date powder. This shows that substitution of date flour and ogi powder had a significant increase ($p<0.05$) in the ash content of the flour blends. Some of the minerals that make up the ash content of a food aid in the metabolism of other organic compounds such as fat and carbohydrate (Ojinnaka and Nnorom, 2015).

Addition of date powder reduced the fat content from 6.36% in sample A (100% maize flour) to 5.17% in sample D (with 30% date powder), but there was however, no significant difference ($p>0.05$) across the samples. This decrease may be attributed to the fact that fat occurs in small amounts in dates, 0.14 g/100g (fresh dates) and 0.38 g/100g, dried dates. The fat distribution in maize kernel is such that 76-83% is found in the germ with 23-15% in the aleurone layer (Al-Farsi *et al.*, 2008). .The removal of the germ and aleurone layer through sieving may have contributed to the low fat content.
The protein content of the blends ranged from 4.81% for sample D (30% date powder) to 6.51 % in sample A (100% maize flour). This was higher than 1.8 to 2.2% reported for ogi by Adejuyitan

et al. (2012). The result is however comparable with 5.13% to 6.37% reported for ogi product carried out by (Emelike *et al.,* 2020).
The crude fibre content in (Table 4.1) of the samples ranged from 2.07 in sample B (10% date powder) to 2.23 in sample D (30% date powder). No significant ($p>0.05$) difference was observed in crude fibre contents amongst flour blends in samples A (100 maize) with 2.15%, B (10% date powder) with 2.07%, C (20% date powder) recording 2.16%, however, they were significantly ($p<0.05$) different from D (30% date powder) with a value of 2.50%, due to the increased substitution of date powder to the ogi flour. It is important to note that crude fibre increases satiety and hence helps to impact some degree of weight management (Mickelson *et al., 2009)* due to low energy and low fat flour formulated. Cereals provides roughage or bulk that aids in digestion, softens stool and lowers plasma cholesterol level in the body (Norman and Joseph, 1995).

The carbohydrate content of the samples had mean values which ranged from 79.03%-83.18% as shown in table 4.1. There was no significant ($p>0.05$) difference among the carbohydrate contents of sample A (100% maize) recording a mean value of 79.03%, sample B (10% date powder with values of 83.18%, sample C (20% date powder) recording 82.37%, and sample D (30% date powder) with a value 82.83%. The carbohydrate content was lowest in sample A (100% maize flour). This however shows that increase in substitution with date powder in the flour blends increased the carbohydrate value of the flour blends. The carbohydrate content contributes to the bulk of the energy of the formulation and this is ideal for babies since they require energy for rapid growth. These composite flours could be used to manage cases of protein-energy malnutrition which is prevalent in most developing countries of the world (Ajatta *et al.,* 2016; Akinola *et al.,* 2015; Manders *et al.,* 2005).

Percentage total sugar content had it means ranging from 2.11 in sample A (100% maize flour to 3.00% in sample D (30% date powder). There was an increase in the sugar content and the sample A (100% maize flour) differed significantly ($p<0.05$) from other samples. This increase may be as a result of the high sugar content of date (44-88%) as reported by (Alsenaien *et al.,* 2015).
The energy value ranged from 397.66 Kcal in sample A (100% maize flour) to 405.16 Kcal in sample B(10% date powder) There was an increase in the energy value, but however, there was no significant difference ($p>0.05$) across the samples. The protein, fat and carbohydrate content of the ogi contributed to the energy values of the samples. The energy values of the samples are comparable to results from a similar work carried out by (Emelike *et al.,* 2020) on ogi product.

Table 1: Chemical Composition of Ogi Produced from Maize Flour and Date Powder

Samples	Moisture %	Ash %	Fat %	Protein %	Fibre %	CHO %	Total Sugar (^{0}Brix)	Energy Value (Kcal/100g)
A	$5.66^{a}\pm0.12$	$0.30^{d}\pm0.00$	$6.36^{a}\pm0.87$	$6.51^{a}\pm0.60$	$2.15^{b}\pm0.07$	$79.03^{a}\pm0.43$	$2.11^{b}\pm0.04$	$397.66^{a}\pm6.10$
B	$3.20^{b}\pm0.35$	$0.40^{c}\pm0.00$	$5.56^{a}\pm0.87$	$5.59^{a}\pm0.57$	$2.07^{b}\pm0.05$	$83.18^{a}\pm0.59$	$2.90^{a}\pm0.03$	$405.16^{a}\pm3.12$
C	$4.02^{ab}\pm1.10$	$0.70^{b}\pm00$	$5.56^{a}\pm0.03$	$5.19^{a}\pm0.00$	$2.16^{b}\pm0.10$	$82.37^{a}\pm1.22$	$2.93^{a}\pm0.04$	$400.25^{a}\pm8.41$
D	$4.57^{ab}\pm0.11$	$1.12^{a}\pm0.04$	$5.17^{a}\pm1.68$	$4.81^{a}\pm0.62$	$2.50^{a}\pm0.19$	$82.83^{a}\pm3.68$	$3.00^{a}\pm0.02$	$393.19^{a}\pm6.44$

[1] ***mean values denoted with the same superscripts are not significantly different (p<0.05)***

[2]**Key:**

A = 100% Ogi flour
B = 90% Ogi flour and 10 % date powder
C = 80% Ogi flour and 10% date powder
D = 70% Ogi flour and 30% date powder

3.2. Functional Properties of Ogi from Maize Flour and Date Flour Blends

Functional properties are important physicochemical properties of foods, that reflects the complex interactions between the structures, molecular confirmation, compositions and physicochemical Properties of food components with the nature of the environment and conditions in which these are measured and associated (Suresh and Samsher, 2013). The result for water absorption capacity (WAC) is as shown in table 4.2. The samples had means which ranged between 0.93g/g in sample C (20% date power) and 1.14g/g in sample A (100% maize flour). A slight decrease in the water absorption capacity of the samples is observed with increasing substitution levels of date powder which could be attributed to the differences in the engagement to form hydrogen and covalent bonds between starch chains and degree of availability of water binding sites of the starches (Hoover and Sosulski, 1986). Similar results were reported by (Adegunwa *et al.*, 2011). Large granular size of the powder may have affected the water binding capacity (Akalu *et al.*, 1998; Bolaji *et al.*, 2014).

Solubility index of the samples significantly ($p<0.5$) increased from 12.45% in sample A (100% maize) to 28.49% in sample C (20% date powder). The increase in solubility is attributable to the

decreasing content of fat with increasing date powder in the substitution. This is in agreement with the work carried out by (Oppong *et al.*, 2015) on a similar work on composite flour. High solubility can show high digestibility of the food which may indicate excellent use for infant feeding.

The bulk density of the samples ranged from 1.94g/g in sample A (100% maize flour) to 2.00g/g in sample D (30% date powder). The variation in bulk density of foods could be due to the variation in starch content of the foods. The higher the starch content, the more likely the increase in bulk density (Iwe *et al.*, 2016). Bulk density is important in determining the packaging requirement, material handling and application in processing food industry (Alsenaien *et al.*, 2015). Low bulk density is a desirable factor in food formulation especially food with less retro degradation (Oladele and Aina, 2009). However, foods high in bulk density is a good physical attribute when determining the mixing quality of a particular matter (Chukwu *et al.*, 2018).

Swelling power of flour granules is an indication of the extent of associative forces within the granules (Adebowale *et al.*, 2012). It showed a decrease from 10.47g in sample A (100% maize flour) to 8.01g in sample C (20% date powder) however, the difference was not significant ($p>0.05$). This may be as a result of the dilution of the starch content of the ogi flour with date powder because starch is a critical component responsible for the swelling power of flour. This is comparable to the results gotten by Zouari *et al.*, (2016). Across all samples the least gelation concentration was at 2%.

Table 2: Functional Properties of Ogi.

Samples	Water Absorption Capacity	Solubility Index	Bulk Density	Swelling Power	Least Gelatin Concentration (%)
A	$1.14^{a}\pm0.04$	$12.45^{d}\pm0.39$	$1.94^{c}\pm0.00$	$10.47^{a}\pm0.19$	$2.00^{a}\pm0.00$
B	$1.03^{ab}\pm0.04$	$17.51^{c}\pm0.77$	$1.96^{bc}\pm0.01$	$9.97^{a}\pm0.19$	$2.00^{a}\pm0.00$
C	$0.93^{b}\pm0.04$	$21.27^{b}\pm0.84$	$1.98^{ab}\pm0.01$	$8.01^{a}\pm1.34$	$2.00^{a}\pm0.00$
D	$1.01^{b}\pm0.10$	$28.49^{a}\pm0.85$	$2.00^{a}\pm0.02$	$8.15^{a}\pm0.18$	$2.00^{a}\pm0.00$

[1] mean values denoted with the same superscripts are not significantly different (p<0.05)

Key:

A = 100% Ogi flour
B = 90% Ogi flour and 10 % date powder
C = 80% Ogi flour and 10% date powder
D = 70% Ogi flour and 30% date powder

3.3. Sensory Properties of Ogi from Maize Flour and Date Flour Blends

Sensory analysis is an important criterion for assessing quality in the development of new products and for meeting consumer requirements. Aroma as evaluated by the panelists indicated equal preference for all samples statistically. The values ranged from 5.80% to 6.9% with sample D (with 30% date powder) as the least and sample B (with 10% date flour) was liked most. However, there was no significant difference ($p>0.05$) across the samples.

The attribute of colour showed a range of 5.45 to 8.35% with sample A (with 100% maize flour) was liked most and sample D (with 30% date powder) recorded the least in likeness. There was a significant difference ($p>0.05$) between the control and other samples, this may be attributed to change in colour due to the addition of the date powder.

Mouth feel values ranged from 5.25 to 6.65% with the lowest recorded in sample D (30% date powder) while sample A (control) with 100% date powder, had the highest (6.65%). There was no significant difference ($p>0.05$) across the samples.

For sourness, the mean values ranged between 5.70 for sample B (with 10% date powder) to 6.85% in sample A (control). The sourness parameter did not show any significant difference, hence, all samples had equal likeness statistically.

The taste parameter showed a range of scores from 5.40 in sample C (with 20% date powder) to 6.95% in sample A (100% maize flour) but however, the results showed equal likeness statistically for all samples by the assessors, there was no significant difference ($p>0.05$). The overall acceptability had mean values ranging from 1.36-6.26%. This showed that sample B (with 10% date powder) was the most liked after the control, sample A (100% maize flour)

Table 3: Mean Sensory Scores of Ogi

Samples	Aroma	Colour	Mouthfeel	Sourness	Taste	Overall Acceptability
A	$6.90^{a}\pm1.62$	$8.35^{a}\pm1.14$	$6.65^{a}\pm1.76$	$6.85^{a}\pm1.81$	$6.95^{a}\pm1.85$	$6.26^{a}\pm1.12$
B	$5.90^{a}\pm1.48$	$5.75^{b}\pm1.71$	$5.50^{a}\pm1.67$	$5.70^{a}\pm1.98$	$5.50^{a}\pm1.99$	$4.18^{b}\pm1.14$
C	$5.60^{a}\pm1.76$	$5.50^{b}\pm2.26$	$5.70^{a}\pm2.05$	$5.85^{a}\pm1.63$	$5.40^{a}\pm1.64$	$2.74^{b}\pm0.94$
D	$5.80^{a}\pm1.74$	$5.45^{b}\pm2.19$	$5.25^{a}\pm2.07$	$5.85^{a}\pm2.06$	$5.85^{a}\pm2.52$	$1.36^{b}\pm0.55$

[1] mean values denoted with the same superscripts are not significantly different ($p<0.05$)

Key:

A = 100% Ogi flour
B = 90% Ogi flour and 10 % date powder
C = 80% Ogi flour and 10% date powder
D = 70% Ogi flour and 30% date powder

4.0 Conclusion

This study showed that date powder can be used to complement ogi flour. However, the use of date powder to supplement ogi flour as applicable in this study resulted in higher ash, fibre, and total sugar content. Based on findings, the following recommendations are noteworthy. Date should be used to fortify infant foods and researchers and investors should work more on utilizing dates in infant meals as it would improve the usage of date crop and enhance its application in other food systems. More work should be done to improve the protein content of the blends.

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