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Physicochemical and sensory properties of cookies produced from whole wheat and whole watermelon seeds flour blends

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Abstract
Composite flour was produced from whole-wheat flour (WWF) and whole-watermelon seeds flour (WWMSF) and its potential in producing cookies was investigated. Five samples were produced at WWF: WWMSF ratios of 100:00; 90:10; 80:20; 70:30 and 60:40. The proximate and functional properties of the composite flours and the sensory properties of the cookies produced from these flour blends were evaluated using standard methods. The proximate analysis results show that the moisture, ash, fibre, protein, and fat increased from 6.60 – 7.42%; 1.99 – 2.78%; 3.20 – 3.57%; 10.51 – 16.88%, and 5.40 – 21.97% leading to a decrease in the carbohydrate content from 72.30 – 47.38% respectively as the level of WWMSF substitution increased in the blends. Moisture content in the range of 6.60 – 7.42% fell far below the 14% recommended for shelf-stable storage of flour products. The 60% WWF: 40% WWMSF had the highest energy value of 454.77 kcal. There was a significant reduction in all the functional properties assessed as WWMSF increased in the blends from 0.78 – 0.73g/ml (bulk density); 160.00 – 138.65% (Water absorption capacity); 122.84 – 116.00% (Oil absorption capacity) and 6.85 – 4.62% (swelling capacity). However, the sensory evaluation results show that cookies produced from 100%WWF were ranked highest in terms of colour (6.10); taste (6.20), and general acceptability (6.80). However, no significant difference exists among the cookies produced up to 20% substitution level in all the sensory attributes; showing the potential of whole wheat and whole watermelon seeds flour blends in the snack industry.

Keywords: Whole-watermelon, water absorption, oil absorption

Introductions
Exploiting and using the available food sources and resources is one potential strategy for achieving nutrition security in poor nations (Champ *et al*., 2003) [9]. Due to their accessibility and affordability, plant foods are the most crucial dietary sources in these nations to meet people's nutrient needs. The disposal of the resulting byproducts is the most frequent issue in the food processing industry. Due to the growth of insects and rodents, this waste material causes ecological issues and costs money to transfer to disposal facilities (Hussein *et al*., 2011) [11]. Fruit seeds are frequently abandoned as waste since they are not currently used for commercial reasons in the food processing sector, whereas the edible components of fruits are processed into products like puree, juice, and pickles (Ajila *et al*., 2007) [4]. Due to their advantageous nutritional characteristics, seeds are also a possible source of beneficial chemicals (Schieber *et al*., 2001) [19]. In Northern Nigeria, Asia, America, and other temperate zones in Europe, watermelon (*Citrullus lanatus*) is a significant seed crop that is grown on a big scale (Sodeke, 2005) [22].
Carotenoids, which are biologically active substances, are abundant in watermelon. Free radicals are fought and neutralized by carotenoids including lycopene, beta-carotene, and alpha-carotene in the body. According to studies, eating a lot of the antioxidants (carotenoids) that are present in foods like tomatoes, watermelons, and other fruits lowers your chance of developing cancer, arthritis, diabetes, and asthma (Seddon *et al*., 2004) [20]. Watermelon is renowned for having a high concentration of micronutrients, including vitamin K, ascorbic acid, riboflavin, iron, and other minerals, in addition to having a low energy value. Phytochemicals, protein, vitamin B, minerals (Including magnesium, potassium, phosphorus, salt, iron, zinc, and manganese), fat, and others are all

abundant in watermelon seeds, which are also recognized to be very nutrient-dense (Braide *et al*., 2012) [8]. According to Nasr and Abufoul (2004) [14], watermelon seed has good functional qualities and has been successfully used in baking and other food preparations. The effectiveness of plant proteins as an ingredient ultimately rests heavily on their positive traits; they have an impact on foods, which in turn depend heavily on their nutritive and functional features. If the functional behaviour of the seed flour in the food chain is understood, better watermelon seed utilisation can be accomplished.

The family Poaceae includes the Triticum species of wheat grain. The bran (the outer layer), germ, and endosperm make up the structure of wheat. According to Peter-Ikechukwu *et al*. (2019) [17], wheat has dietary fibre (0.5%), mineral content (7.2%), protein (25%), and fat (8-13%). Wheat grains are a common ingredient in flour, leavened, flat, and steamed breads, cookies, cakes, breakfast cereal, pasta, and noodles. They are also used in the fermentation process that creates beer and other alcoholic beverages. Due to its gluten content, which other cereals lack (Ishiwu *et al.,* 2014) [12], and the fact that it enhances baking quality (Kumar *et al.,* 2011; Peter-Ikechukwu *et al.,* 2019) [13, 17], wheat continues to be the preferred flour for baked goods.

A type of confectionery food known as cookies is often dried to have a low moisture content and a softer tongue feel. They are prepared food items that provide essential dietary and digestive elements. Wheat flour, fat (margarine), sugar, and water are the essential components of cookies, though they can also contain other ingredients such as milk, fat, an emulsifier, an aerating agent, flavouring, and colour (Ajibola *et al.,* 2015) [3]. To satisfy the precise nutritional requirements of consumers, however, cookies can be strengthened and supplemented. This is crucial because it lowers the risk of certain nutrition-related chronic diseases, which are driven mostly by consumer health trends in the food business. According to research by Boober *et al.* (2006) [7], eating fat and sugar has been linked to health issues like obesity, diabetes, and other coronary heart illnesses. The objectives of this research are the formulation of composite flour blends of wheat flour and watermelon seed flour and the determination of the proximate, functional, and organoleptic properties of the cookie samples.

Materials and Methods

Collection of Raw Material

Whole wheat (*Triticum aestivum*) was bought from Poly Mini market in Owo local government Area all in Ondo State and water melon seeds were bought from Abubakar Mahmud Gumi Market in Kaduna North local government area in Kaduna State.

Preparation of Watermelon seed Flour

The watermelon seed flour was produced according to the method. The seeds were sorted on a clean tray to remove stones, chaffs and other unwanted materials. The washed seeds were dried at 50±2 °C in cabinet dryer for 2-3hours. The dried seeds were milled with a laboratory-type blender (Marlex, Ecella model, Kanchan International Limited, Daman, India) and sieved through 125 µm mesh. The flour was packaged in high density polyethylene until required for use and analyses.

Formulation of Flour Blends

The whole wheat and watermelon seed flour were grated to give four samples. Sample A consist of 100% Whole wheat flour, Sample B 90% Whole watermelon seed flour with 10% coconut flour, Sample C 80% whole wheat flour with 20% watermelon seed flour, Sample D 70% whole wheat flour with 30% watermelon seed flour and Sample E consist of 60% whole wheat with 40% watermelon seed flour. The flour were mixed thoroughly with ingredient and baked.

Proximate Analysis

Protein, fat, fibre, moisture and ash were determined by the method of analysis of the Association of Official Analytical Chemists (2005) while carbohydrate was determined by difference.

Functional Properties of Flour Blends

Water absorption capacity determination

Water absorption capacity is an index of the amount of water retained within a food matrix under certain conditions (Ayinde *et al*., 2012) [6]. It usually refers to entrapped water but includes bound water and hydrodynamic water and depends upon the condition of determination. It was determined using the procedure as modified by Adebowale *et al*., (2005) [25].

Oil Absorption Capacity Determination

Oil absorption capacity is an index of the amount of oil retained within a protein matrix under certain conditions. It was determined using the method of as modified by Adebowale *et al*., 2005 [25].

Bulk density determination

The method of Sathe *et al*., (1982) [26] was used with slight modification.

Swelling index determination

The swelling index of the samples was determined by the method of Ukpabi and Ndimele (1990) [27].

Results

The results of the proximate and functional properties of flour blends produced from Whole-Wheat Flour (WWF) and Whole Water Melon seeds flour (WWMSF) and the sensory properties of cookies produced from these blends are shown in the tables below.

Table 1: Proximate Composition of whole wheat and whole watermelon seeds flour blends

	WWF: WWWSF				
	100:00	**90:10**	**80:20**	**70:30**	**60:40**
Moisture (%)	6.60	6.78	6.95	7.21	7.42
Ash (%)	1.99	2.16	2.34	2.54	2.78
Fibre (%)	3.20	3.31	3.42	3.49	3.67
Protein (%)	10.51	12.14	13.73	15.31	16.88
Fat (%)	5.40	9.51	13.67	17.82	21.97
Carbohydrate (%)	72.30	66.10	59.89	53.63	47.38
Energy (Kcal)	379.84	398.55	417.51	436.14	454.77

Table 2: Functional Properties of whole wheat and whole watermelon seeds flour blends.

	WWF: WWWSF				
	100:00	**90:10**	**80:20**	**70:30**	**60:40**
Bulk density (g/ml)	0.78	0.74	0.70	0.67	0.63
Water Absorption Capacity (%)	160.00	154.64	149.31	143.97	138.65
Oil Absorption Capacity (%)	122.44	121.07	119.43	117.71	116.00
Swelling Capacity (%)	6.85	6.31	5.77	5.21	4.62

Table 3: Mean Sensory properties of cookies produced from whole wheat and whole water melon seeds flour blends.

	WWF: WWWSF				
	100:00	90:10	80:20	70:30	60:40
Colour	6.10±1.197[a]	5.80±1.317[ab]	6.10±0.738[a]	4.60±1.350[bc]	4.20±2.098[c]
Taste	6.20±0.789[a]	5.70±0.949[ab]	5.40±0.843[ab]	5.10±1.101[ab]	4.70±1.767[b]
Aroma	5.40±1.578[a]	5.90±0.876[a]	5.20±0.632[a]	5.30±1.252[a]	5.70±1.160[a]
Texture	5.60±1.1955[ab]	5.80±1.135[a]	5.40±1.174[ab]	5.20±1.687[ab]	4.10±1.792[b]
General Acceptability	6.80±0.422[a]	5.90±0.568[ab]	6.00±0.667[ab]	5.10±1.595[bc]	4.40±1.955[c]

Means with the same superscript along the row are not significantly different

Discussion

The results of the proximate composition (Table 1) show that the moisture content increased as the whole watermelon seeds flour (WWMSF) increased in the blends from 6.60-7.42%. The increase in moisture content may be due to addition effect as it was reported that whole watermelon seeds flour had a higher moisture content of 8.25% (Tusneem *et al.*, 2020) [24] when compared with whole wheat flour. WWMSF-supplemented biscuits were found to show higher moisture content and this can be due to the hygroscopic nature of seed flour (Tuseem *et al.*, 2020) [24]. The moisture content range fell below 14% recommended for shelf-stable storage of flour products as reported by Adeleke and Odedeji (2010) [2].

The ash content of the flour blends increased from 1.99 – 2.78% as the inclusion of WWMSF increased in the blends. The increase in the ash content could be due to the higher content of the WWMSF in whole wheat flour. Watermelon seeds have been reported to contain an appreciable amount of minerals and fat (Odo *et al.*, 2021) [15]. Similarly, the addition effect was also observed for fibre, protein and fat; their values increased progressively with increasing level of WWMSF from 3.20 – 3.57%; 10.51 – 16.88% and 5.40 – 21.97% respectively. The implication of this is that supplementation of WWF and WWMSF wounds have greatly improved these nutrients. A significant quantity of protein and fat in the whole watermelon seeds flour (Tusneem *et al.*, 2020) [24].

The high protein content in the flour blends would be of nutritional importance in Nigeria where many people are unable to afford foods with high protein because such foods are costly. However, flour blends supplemented with 40% WWMSF was significantly higher in all the proximate components analyzed in this study apart from carbohydrate.

The fibre contents in the blends ranged from 3.20 – 3.57%. Though crude does not contribute nutrients to the body, it adds bulk to food thus facilitating bowel movements in men (Gordon, 1999) [10]. The carbohydrate content decreased from 72.30-47.38%. This result shows that watermelon seeds are not a good source of carbohydrates when compared to legumes (Salunkhe *et al.*, 1992) [18]. The trend observed in this result is in line with the claims of other workers as reported by Okoye *et al.* (2008) [16]. The energy value of the blends increased as the level of WWMSF increased in the flour blends from 379.84 – 454.77kcal. The high energy values observed in the flour blends produced in this study may be due to the high protein, fat, and carbohydrate contents of the blends used for their production.

The results of the functional properties of flour blends as shown in Table 2 indicate that 100% WWF had the highest bulk density (0.78g/ml) and this decreased as the level of substitution with WWMSF increased to 40% with a value of 0.63%. The bulk density of food is affected by the particle size and the density of the food; and it is an important factor in food packaging (Akpapunam *et al.*, 1997) [5].

The water absorption capacity (WAC) and oil absorption capacity (OAC) ranged between 138.65 – 160.00% and 116.00 – 122.84% respectively. A decrease in the WAC and OAC was recorded in this study as the level of WWMSF increased in the blends. WAC is important in foods where water will be imbibed without the dissolution of protein, thus increasing their viscosity and body thickening (Seena and Sridhar, 2005) [21]. Moreover, the values obtained for OAC indicate that it will increase the functionality of these composite flours in retaining flavour and improvement on the mouthfeel.

There was a decrease in the values of swelling capacity as the percentage substitution of WWMSF flour increased. Swelling capacity was highest in 100% WWF (6.85%) while the lowest value of 4.62% was obtained for the 60% WWF and 40% WWMSF blend. The mean sensory scores of cookies produced from WWF and WWMSF blends are shown in Table 3. The scores of various sensory attributes were low in all the cookie samples produced from the different blends. In general, cookies produced from 100% WWF were rated best in colour (6.10); taste (6.20), and general acceptability (6.80) while the sample with 90% WWF and 10% WWMSF was rated best in aroma (5.90) and texture (5.80). There was no significant difference among 100WWF; 90WWF: 10WWMSF and 80WWF: 20WWMSF in all the sensory attributes evaluated in the study implying that would-be consumers of the cookies will accept cookies produced from any of the flour blends.

Conclusion

Cookies of acceptable quality is similar to those produced from whole-wheat flour were produced from whole-wheat flour (WWF) and whole-watermelon seeds flour (WWMSF) blends at different ratios. Substitution of WWF with WWMSF up to 40% produced good results. From this study, it was observed that the flour produced had better nutritional quality than those produced from 100% WWF because the protein, ash, fibre, and fat contents increased as the level of substitution with WWMSF increased. Moreover, there was a reduction in all the functional properties assessed such as bulk density, water absorption capacity, oil absorption capacity, and swelling capacity. However, the values obtained indicate that the flour blends will find application in the baking industry. Cookies produced from the flour blends were rated low in all the sensory attributes assessed in terms of mean sensory scores. However, cookie produced from 100% WWF was rated best in terms of colour, taste, and general acceptability. However, no significant difference exists among the cookies produced from 100% WWF and flour blends substituted with WWMSF up to 20% in all the sensory attributes, suggesting the potential use of these blends in the snack industry.

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