International Journal of Environment
Volume: 11 | Issue: 01| Jan. - March| 2022

EISSN: 2706-7939 ISSN: 2077-4508
DOI: 10.36632/ije/2022.11.1.2
Journal homepage: www.curresweb.com
Pages: 10-22

Nutritional Evaluation of Watermelon and Gurmamelon Seeds Powder and Quality Characteristics of Fortified Biscuits

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Received: 05 Feb. 2021 **Accepted:** 10 Mar. 2022 **Published:** 20 Mar. 2022

ABSTRACT

This study was carried out to investigate the utilization of watermelon seed powder (WMSP) and gurmamelon seed powder (GMSP) as replacements for wheat flour at different levels (5.0, 10.0, 15.0, and 20.0%) to prepare biscuits rich in protein and minerals. The obtained results revealed that WMSP and GMSP are very rich in protein, ash, and fiber compared with wheat flour, (72%). Furthermore, the total phenolics, flavonoids, and antioxidant activity of WMSP and GMSP showed a higher significant effect than wheat flour 72%. Wheat flour (72%) contains lower values of all determining elements except for sodium and potassium compared to WMSP and GMSP. In addition, WMSP and GMSP had higher values of phosphorus, magnesium, zinc, manganese, and iron. The total amino acids of WMSP and GMSP were 51.40 percent and 58.08 percent, respectively. Furthermore, GMSP was richer in essential and non-essential amino acids than WMSP. The total saturated fatty acid of gurmamelon seed oil was higher (25.58%) than that of watermelon seed oil (18.06%). In contrast, crude protein, ether extract, ash, and crude fiber content increased in biscuit products. Moisture and carbohydrate value decreased gradually as the substitution levels of WMSP and GMSP increased. From the results of sensory evaluation, it should be noted that fortification of weat flour with WMSP and GMSP until 15% is acceptable for the sensory evaluation of biscuits. Based on the obtained results, the new product of biscuits containing WMSP and GMSP can be used to cover the protein and mineral nutritional needs of schoolchildren in developing countries and could be recommended as food aid in institutional feeding programs for pupils in different school stages.

Keywords: Watermelon seeds, Gurmamelon seeds, Minerals, Fatty acids, Amino acid and biscuits.

1. Introduction

Watermelon *citrullus lanatus* var. Thunb and Gurmamelon. *Citrullus lantus* var. colocynthoides is a typical fruit from the family of *Cucurbitaceae* grown in the warmer parts of the world whose seeds are underutilized. The seeds are a rich source of dietary fiber (> 5%), high in protein (20%), fat (35%), magnesium, calcium, potassium, iron, phosphorus, and zinc, with some excellent functional properties that have been found to be effective in baking (Maoto *et al.,* 2019; Rekha and Rose 2016 and Wan-Shafiin *et al.,* 2020).

Watermelon seeds are known to be highly nutritional: they are rich sources of protein, B vitamins, minerals such as magnesium, potassium, phosphorus, sodium, iron, zinc, manganese, copper, and fat, among others, as well as phytochemicals (Braide *et al.,* 2012, and Wan-Shafiin *et al.,* 2020). Also, diverse bioactive compounds that show antioxidative, anti-inflammatory, antimicrobial, and antiulcer functionalities have been retrieved from watermelon seeds (Gill *et al.,* 2010; Hassan *et al.,* 2011 and Lucky *et al.,* 2012).

According to Adaramola and Onigbinde (2016), watermelon seeds have a strong food flavour and significant quantities of vitamin C, riboflavin, and fat starch. Additionally, the proteins inherent in the seed show good digestibility and fewer antinutritional characteristics (Lakshmi and Kaul, 2011). The predominant proteins contained there in are arginine, leucine, aspartic acid, and glutamic acid, and

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they have excellent functional properties that have been found to be effective in baking (El-Adawy and Taha, 2001 and Ogodo *et al.,* 2015). These attributes make the seed a candidate for sustainable food supplementation. In many countries, the seeds are used in cooking oil production at a subsistence level, while in other countries, they are restricted for additive purposes. They are mostly used as condiments, soup thickeners, garnishes, flavour enhancers, and fat binders (Raihana *et al.,* 2015).In addition, Jensen *et al.* (2011) and Olayinka and Etejere, (2018) showed that these seeds have quality nutritional values and could be consumed as a snack or used for baking, the seeds are utilized directly for human consumption in various forms, such as snacks in India, Arabian and African countries, as an additive in various dishes, and for decorating cakes. To date, many studies involving watermelon seed fortified pastries have been conducted with cookies and biscuits (Ubbor and Akobundu, 2009 and Wani *et al.,* 2015). For instance, Wani *et al.,* (2015), reported the use of watermelon seed cake for the fortification of cookies, in addition, the work reported a significant improvement in dough stability and cookie nutritional, textural, and sensory properties. Omobolanle *et al.* (2017) showed that cookies produced from a combination of wheat and watermelon seed flour had the highest crude fiber and ash content, while wheat cookies had the highest carbohydrate content and low moisture content, which gives the cookies longer shelf life. It also shows that the cookies are safe for human consumption considering their low microbial content of less than 10. Therefore, the aim of the present work was to evaluate the nutritional value and bioactive compounds of (WMSP) and (GMSP) and to utilize them in biscuit processing as a new food industry product in the Egyptian market rich in protein and minerals.

2. Materials and Methods

2.1. Materials

I. Watermelon (Red) seeds *Citrullus lanatus* var. Thunb and Gurmamelon seeds (Nubian or Seed melon) *Citrullus lantus* var. colocynthoides were purchased in season 2019-2020 from a local market in Tanta, EL-Gharbia Governorate, Egypt.

II. Wheat flours (72% extraction) were purchased from Delta Middle and West Milling Company, Tanta, Egypt.

III. Salt, sugar, shortening, baking powder, skimmed milk powder, and whole eggs were purchased from the local market of Tanta city in El-Gharbia Governorate, Egypt.

V. All the chemicals used in this study were obtained from EL-Gomhouria pharmaceutical company, of Tanta City in EL-Gharbia Governorate, Egypt. All the other chemicals were analytical grads.

2.2. Methods

I. Preparation of raw samples

The seeds were cleaned and washed off any sticky residue before being dried in a drying oven at 45 ° C for 24 hours. The dried seeds were ground in a mill and sifted through a 0.5 mm diameter mesh. Completely ground seeds were placed in a colored bottle and refrigerated (+4 °C) until use (Ubbor and Akobundu, 2009).

2.3. Analytical methods

I. Chemical composition and caloric value of samples

Moisture, crude protein (N x 6.25), ether extract, ash, and crude fiber content were determined according to the methods of A.O.A.C. (2005). Total and available carbohydrates were calculated by difference according to the methods of A.O.A.C. (2005). The energy value was calculated according to James (1995).

(kcal.100 g-1) energy value = (g protein× 4) + (g lipids ×9) + (g carbohydrates× 4).

II. Determination of minerals

Samples were prepared for mineral determination according to the method of the A.O.A.C. (2005).

- **a-** Total phosphorus (mg/100 g) was determined by the ascorbic acid technique using the colorimetric method described by Murphy and Riley (1962).
- **b-** Pearson (1976) recommended using a flame photometer to estimate the potassium and sodium contents of samples (mg/100 g).

c- The analysis of the iron, magnesium, manganese, copper, zinc, and calcium contents of samples was conducted using the atomic absorption spectrophotometer Perken Elmer Model 2180 and following the methods of Pearson (1976).

III. Determination of amino acids

Amino acid content was determined based on the method described by Sadasivam and Manickam (1992). The tryptophan content of samples was determined colourimetrically after subjecting them to alkaline hydrolysis as outlined by Blauth *et al.,* (1963).

V. Determination of anti-nutritional factors

Saponin content was determined using the spectrophotometric method described by (Brunner, 1984).

Tannin content of watermelon and Gurmamelon seeds was estimated using modified vanillin-Hcl in methanol methods described by Price and Butler (1978).

Alkaloid content was determined by the method described by Harborne , (1973).

Extraction of Total Phenolic Compounds: Total phenolic compounds were extracted by ethanol 70% according to the method described by Mohdaly *et al.,* (2010).

VI. Determination of total phenolic compounds: Total phenolic compounds of the extracts were determined spectrophotometrically using Folin-ciocalteau reagent according to the method described by Kahkonen, *et al.* (1999) and used to estimate the phenolics-acid content using a standard curve prepared using gallic acid.

VII. Determination of total flavonoids: Total flavonoid was determined by the method of Marinova *et al.* (2005) and used to estimate the flavonoids content using a standard curve prepared using catechin.

VIII. Determination of DPPH· radical scavenging capacity

Antioxidant activity (DPPH) assay Antioxidant activity was measured using the (2, 2-diphenyl-1- picrylhydrazyl) DPPH method described by Lee *et al.* (2003).

IX. Fatty acids composition of Watermelon and Gurmamelon oils

The methyl esters were prepared using benzene, methanol, and concentrated sulfuric acid (10:86:4), and the methylation process was carried out for one hour at 80-90 ºC according to Stahl (1967). Identification of the fatty acid methyl esters was performed by G.L.C using a spectophysic integrator (A.O.A.C., 2005).

2.4. Technological methods

I. Preparation of Biscuits

The method of Alobo (2001) was used to prepare the biscuit samples. Blends containing 5, 10, 15, and 20% of watermelon or gurmamelon seeds powder were used as a replacement for wheat flour (72% extraction). The basic ingredients were 455g flour blends, 200g shortening, 200g sugar, 50g whole egg, 5g baking powder, and variable water. The biscuits were baked for 30 minutes in an electric oven set to 175± 5ºC. Biscuits were allowed to cool at room temperature for 30 minutes after removal from the oven and were then divided into two lots. One lot was initially used for sensory evaluation measurements, and the second lot was for chemical analysis.

II. Physical properties of biscuits

According to Manohar and Rao (1997), the diameter (D) and thickness (T) of five biscuits were measured in millimeters.

The spread ratio was calculated by dividing the diameter of the biscuit (mm) by their thickness (mm).

III. Sensory evaluation of biscuits

Watts *et al.* (1989) used a semi-trained panel of twenty members to provide organoleptic characteristics for different prepared biscuits using ten-point hedonic-scale ratings for appearance, texture, colour, flavour, and overall acceptability. Liked extremely 9, Like very much 8, Liked moderately 7, Liked slightly 6, Neither liked nor disliked 5, Disliked slightly 4, Disliked moderately 3, Disliked very much 2 and Disliked extremely1.

2.5. Statistical analysis

The data were statistically analyzed with analysis of variance, and the means were tested further with the DMRT test (Duncan's multiple range test, DMRT) by Steel and Torrie (1980).

3. Results and Discussion

3.1. Chemical composition and bioactive compounds of WMSP, GMSP, and WF72%

The approximate chemical composition of WMSP, GMSP, and WF72% is given in Table (1). The obtained results show that WMSP and GMSP contain lower moisture content (8.82 and 7.07% respectively) than those of wheat flour, 72 % (11.22%). This helps in keeping the quality of seeds during storage in proper condition proper condition. At this level of moisture, micro-organisms' growth and biochemical reactions are usually inhibited. (Ali, 2003), Furthermore, the low moisture content in the melon seed powder will help to improve its lifespan. (Jacob *et al.,* 2015).

Table 1: Chemical composition (%), bioactive compounds and antioxidant activity of WMSP and GMSP on a dry weight basis.

Samples / Compound	WMSP	GMSP	WF (72%)
Moisture%	8.82 ±0.15b	7.07±0.11[c]	11.22±0.13[a]
Dry matter	91.18±0.34b	92.93±0.25a	88.78±0.13[c]
Crude Protein%	17.03±0.21a	16.50 0.26b	10.16±0.14[c]
Ether extract%	28.59 ±0.27b	31.58 ±0.31a	0.95±0.16[c]
Ash%	3.92±0.15a	3.57 ±0.16b	0.65±0.15[c]
Crude fiber%	36.63±0.62a	35.41 ±0.90ab	0.78±0.15 [c]
Total carbohydrates.%	46.74 ±0.26c	49.26 ±0.25b	88.24±0.15 [a]
Available carbohydrates.%	10.11±0.13c	13.85±0.17b	87.46±0.60a
Caloric value (K. cal./100g)	512.39±0.33b	547.26±0.28a	402.15±0.20 c
Total phenolic (mg gallic acid /100 g)	0.74±0.O3a	0.76±0.09a	0.56±0.08b
TFC (mg catechin /100 g)	0.63±0.04a	0.66±0.07a	0.08±0.06b
DPPH(%)	74.63±0.26a	71.36±0.66b	45.33±0.17c

Each value is an average of three determinations ± standard deviation.
Values followed by the same letter in rows are not significantly different at P<0.05.
WMSP: Watermelon seeds powder. GMSP: Gurma melon seeds powder.WF (72%): wheat flour 72%.
TPC: Total phenolic content; TFC: Total flavonoid content. DPPH(%):Antioxidant activity

However, WMSP had significantly higher contents of crude protein, ash and crude fiber (17.03, 3.92 and 36.63%, respectively) compared to GMSP (16.50, 3.57 and 35.41%) and WF72% (10.16, 0.65 and 0.78%, respectively). GMSP contained a higher amount of ether extract (31.58%) than WMSP (28.59 %) while the lowest value of ether extract was 0.95% for WF72%. This finding may increase the interest in WMSP and GMSP as high protein and oil sources in some food formulations. When compared to WMSP, GMSP, and WF72%. WF72% contains more total carbohydrates (88.24%) and available carbohydrates (87.46%). From the same Table, it could be noticed that GMSP contained the highest value of caloric (547.26 kcal/ 100g) followed by WMSP and wheat flour 72%, which contained (512.39 and 402.15 kcal/100g) respectively. The obtained results agree partially with those of Ubbor and Akobundu (2009); Akusu and Kiin-Kabari (2015); Mahla *et al.,* (2018) and Kausar *et al.,* (2019). This variation in the seed oils may have been attributed to environmental factors as indicated by Di-Vincenzo *et al.* (2005). Also, results presented in Table (1) show total phenolic compounds, total flavonoids and antioxidant activity (DPPH%) of WMSP, GMSP, and WF72%. It was observed from these results that total phenolic compounds and total flavonoids content were higher in GMSP and WMSP than WF72% and the differences between GMSP and WMSP were not significat while the

WMSP were higher than them in DPPH, this agrees with Tabiri , *et al.,* (2016); Awaad and.El Gamel (2020) and Petchsomrit *et al.,* (2020).

3.2. Mineral content

Some minerals and elements are essential for human nutrition. Some are important components in producing hemoglobin in the blood. Magnesium and manganese are for the activation of enzymes and stimulating insulin. Calcium and phosphorus are crucial for bones, and some of them are very important for supporting vitamins' actions. Potassium is very important for cardiovascular function, and zinc helps control blood sugar levels (National Academy of Sciences, 2001). The data presented in Table (2) demonstrates that WF72%, compared to WMSP and GMSP, contains lower values for all determining elements except potassium. It is also apparent from the same Tables that there was a significant enhancement in the mineral content of WMSP and GMSP. Furthermore, WMSP had a high potassium content (29.61 mg/100g), calcium content (92.7 mg/100g), magnesium content (490.25 mg/100g), manganese content (10.49 mg/100g), copper content (0.55 mg/100g), and iron content (8.48 mg/100g), whereas GMSP had a high sodium content (34.21 mg/100g), phosphorus content (721.40 mg/100g), and zinc content (6.39 mg). In addition, the iron content of WMSP is ten times higher than that of wheat flour. Schoolchildren, who mostly need more iron to avoid anemia, especially in developing countries. Therefore, it could be mentioned that fortification of wheat flour with WMSP and GMSP can produce bakery products with high levels of minerals, especially iron. These results are supported by Adesuyi and Ipinmoroti (2011); El-Adawy and Taha (2001); Acar *et al.,* (2012) and Ani *et al.,* (2020).

Table 2: Mineral contents (mg/100g) of WMSP and GMSP and wf 72%.

Minerals	WMSF	GMSF	WF72%
	Macroelements		
Potassium(K)	29.61±2.6[b]	27.74±2.9[b]	140.0±1.1[a]
Sodium(Na)	33.07±0.25[b]	34.21±0.08[a]	25.11±0.21[c]
Calcium(Ca)	92.7±0.82[a]	88.42±0.97[b]	12.08±0.30[c]
Phosphorus(P)	645.00±4.5[b]	721.40±4.7[a]	138.97±1.21[c]
Magnesium(Mg)	490.25±2.8[a]	480.00±2.7[b]	118.0±1.23[c]
	Microelements		
Copper(Cu)	0. 67±0.04a	0. 55±0.06b	0.29±0.05c
Zinc(Zn)	5.34±0.19b	6.39±0.17a	0.41±0.07c
Manganese(Mn)	10.49±0.12a	9.75±0.19b	0.69±0.06c
Iron(Fe)	8.48 ±0.15a	7.02±0.06b	0.71±0.03c

Each value is an average of three determinations ± standard deviation.
Values followed by the same letter in rows are not significantly different at P<0.05.
WMSP: Watermelon seeds powder. GMSP: Gurma melon seeds powder.WF (72%): wheat flour 72%.

Therefore, it could be mentioned that fortification of wheat flour with watermelon and gurmamelon seed powder can produce balady bread and biscuits with high levels of minerals. Results show that WMSP and GMSP are rich in minerals and could aid in digestion, the formation of strong bones and teeth, as well as hemoglobin formation. The variation in mineral composition could be due to the climate, species, soil type, water, and the cultural practices adopted during planting (Betty *et al.,* 2016).

3.3. Amino acids composition of watermelon and gurmamelon seeds

The nutritive value of food, especially protein, depends not only on its amino acid profile in general but also on the quantities of the essential amino acid content in particular (Afify *et al.,* 2012). The results are indicated in the Table. (3) showed the identification of 18 essential and non-essential amino acids by using the amino acid analyzer to measure the number of amino acids in WMSP and GMSP. Furthermore, the GMSP was richer in essential and non-essential amino acids than the WMSP. The total amino acids of WMSP and GMSP were 51.40 and 58.08%, respectively. As for essential amino acids, it could be observed that Phenylalanine was the dominant acid in WMSP and GMSP that were recorded (3.46 and 3.81%, respectively), followed by Isoleucine, which was recorded (3.10 and 3.32%, respectively). Meanwhile, tryptophan was the lowest amino acid in WMSP and GMSP that was recorded (0.46 and 0.73%, respectively). Concerning non-essential amino acids, it was found that glutamic acid was the highest amino acid among all of the other acids in WMSP and GMSP that were recorded (11.36 and 12.40%, respectively). Meanwhile, arginine was the second level in both WMSP and GMSP that was recorded (6.22 and 6.59%, respectively). Meanwhile, alanine was the lowest amino acid in WMSP and GMSP that was recorded (1.53 and 1.30%, respectively). Most of the amino acid values are comparable with those of most vegetable proteins, as determined by many investigators (El-Adawy *et al.,* 2001; Mune *et al.,* 2011; Ogunlade *et al.,* 2011; Nasiru and Oluwasegun 2019).

Table 3: Amino acids profile (g/100g protein) of WMSP and GMSP.

Amino acids	WMSP	GMSP	FAO/WHO** (1973)
	A-Essential amino acid		
Valine	1.85	1.97	5.0
Leucine	2.65	2.91	7.0
Isoleucine	3.10	3.32	4.0
Methionine	0.83	0.98	
Cysteine	0.64	0.83	
Methionine+ Cysteine	1.47	1.81	3.5
Phenylalanine	3.46	3.81	
Tyrosine	0.99	1.40	
Phenylalanine +Tyrosine	4.45	5.21	6.0
Threonine	2.99	3.11	4.0
Lysine	1.03	1.19	5.50
Tryptophan*	0.46	0.73	1.0
Total Essential amino acid	19.00	21.25	36
	B-Non-essential amino acid		
Glycine	2.03	2.59	
Alanine	1.53	1.30	
Serine	2.87	3.37	
Aspartic acid	2.58	3.49	
Glutamic acid	11.36	12.40	
Proline	3.2	4.03	
Arginine	6.22	6.59	
Histidine	2.61	3.06	
Total Non-essential amino acid	32.40	36.83	
Total amino acid	51.40	58.08	
C-PER B	0.83	1.00	
BVB	58.73	60.43	

* Tryptophan was determined calorimetrically. ** FAO/WHO (1973).
C- PER: The computed protein efficiency ratio. B.V: Biological value.
WMSP: Watermelon seeds powder. GMSP: Gurma melon seeds powder.

Generally, the average concentration of non-essential amino acids was higher than the essential amino acids in watermelon and gurmamelon seeds. Similar data was previously reported by Usman *et al.,* (2010), revealing the prevalence of glutamic acid and aspartic acid in watermelon seeds. In addition, variety happens as indicated by genotype and the geographical and environmental conditions in which watermelons are developed. Furthermore, glutamic acid is an important amino acid with numerous capacities in the body. It is a building block of protein and a critical part of the immune system. Likewise, glutamic acid has an extraordinary role in intestinal health. Your body naturally produces this amino acid, and it is also found in numerous foods. The computed protein efficiency ratio (C-PER) and biological value (B.V) of WMSP and GMSP were lower than those of standard casein protein (PER = 2.50) and (BV = 76.23) as given in Table (3). The lower (C-PER) and (BV) values were recorded in WMSP compared with GMSP. The computed protein efficiency ratio was 0.83 in WMSP and 1.00 in GMSP. Both of these nutritional parameters were based on the essential or non-essential amino acid content of WMSP and GMSP. Our findings coincide with those of El-Adawy *et al.* (2001) and Egbuonu ,2015).

3.4. Some anti- nutritional factors of WMSP and GMSP

Tannins have the property of complexing with minerals (Adewusi and Osuntogun 1991). The data are given in Table (4) showed some antinutritional factors such as saponins, tannins, and al kolaids, there were significantly different in WMSP and GMSP.

Table 4: Some ant nutritional factors content of WMSP and GMSP (on a dry weight basis).

Ant- nutritional factors (mg/ 100g)	Samples	
	WMSP	GMSP
Saponins	3.55±0.14[a]	2.62±0.12[b]
Tannins	27.08±0.08[a]	22.57±0.18[b]
AL kolaids	0.37±0.02[a]	0.31±0.04[b]

Each value is an average of three determinations ± standard deviation.
Values followed by the same letter in rows are not significantly different at P<0.05.
WMSP : Watermelon seeds powder. GMSP: Gurma melon seeds powder.

Furthermore, WMSP had (3.55 mg/100 gm) saponins, (27.08 mg/100 gm) tannins, and (0.37 mg/100 gm) al kolaids. While, GMSP had (2.62mg/100gm) of Saponins, (22.57 mg/100gm) of tannins, and (0.31mg/100 gm) of AL kolaids. These results were near to El- Adawy *et al.,* (2001) ; Johnson *et al.,* (2012) ; Jacob *et al.,* (2015) and Odo *et al.,* (2021).

3.5. Fatty acids composition of watermelon and gurmamelon seeds oils

The fatty acid composition of watermelon and gurmamelon seed oils is presented in Table (5). Results show the most abundant fatty acid found in the seed oil were linoleic acid (C18:2), followed by oleic acid and palmitic acid, respectively (Biswas, 2017 and Petchsomrit *et al.,* 2020). Generally, the total saturated fatty acid of gurmamelon seed oil was higher (25.58%) than that of watermelon seed oil (18.06%). Among the saturated fatty acids, the highest concentration was palmitic acid (11.06 and 13.26%, respectively) in watermelon and gurmamelon seed oil.

As for unsaturated fatty acids, it was clear that the highest concentration was linoleic (67.88 and 60.14%, respectively) in watermelon and gurmamelon seed oils, followed by oleic acid (12.55 and 12.77%, respectively). Thus, they may be used as edible cooking oils, salad oils, or for the manufacture of margarine. In terms of linoleic acid, the result are consistent with those of El-Adawy and Taha (2001) ; Baboli and Kordi (2010); de Conto *et al.,* (2011); Cheikhyoussef *et al.,* (2017); Petchsomrit *et al.,* (2020), and Ouassor *et al.,* (2020). Linoleic and oleic acid-rich oils are particularly important for the human diet. In addition, they help maintain membrane fluidity at the water barrier of the epidermis and can be further enzymatically oxidized into a variety of derivatives involved in cell signaling. Furthermore, the presence of high amounts of essential fatty acid linoleic acid suggests that these oils are highly nutritious oils due to the ability of unsaturated vegetable oils to reduce serum cholesterol, Ouassor *et al.,* (2020).

3.6. Chemical composition of biscuits

The results of the chemical composition of biscuits made from different levels of WMSP and GMSP are recorded in Table (6). The obtained results showed that the moisture, crude protein, ether extract, ash, and crude fiber content increased. While the carbohydrate value gradually decreased as the substitution levels of WMSP and GMSP increased. These results are in harmony with the findings of Ubbor and Akobundu (2009) and Peter-Ikechukwu *et al.,* (2018). They reported that, supplementation of biscuits with WMSP could improve the protein content, while their carbohydrate value decreased gradually with increasing the substitution levels, as it has been found to contain essential nutrients needed by the body.

Table 5: Fatty acid composition of watermelon and gurmamelon seeds oils.

Constituent Fatty acid%	Watermelon seeds oils.	Gurmamelon seeds oils.
Undecanoic acid C11:0	-	0.13
Lauric acid C 12:0	-	0.54
Palmitic acid C16:0	11.09	13.26
Margaric acid C17:0	0.13	-
Stearic acid C18:0	6.81	11.54
Arachidic acid C20:0	0.20	0.41
Total saturated fatty acids (SFA)	18.23	25.88
Palmitoleic acid ω7 C16:1	-	0.12
Oleic acid C18:1 n9	12.55	12.77
Vaccenic acid C18:1 n7	0.59	0.60
Linoleic acid C18:2 n6	67.88	60.14
Linolenic acid C18:3 n3	0.37	0.29
Non Identified fatty acids	0.55	1.00
Total unsaturated fatty acid (USFA)	81.39	73.92
Saturated to unsaturated FA ratio	1:4.5	1: 2.89
Total (FA)	99.45	99.00

Table 6: Chemical composition (% on a dry weight basis) of biscuits substitution with different levels of WMSP and GMSP.

Samples	Moisture (%)	Crude Protein (%)	Ether extract (%)	Crude Fiber (%)	Ash (%)	T.C. (%)
Control biscuit	10.06 ± 0.12[a]	7.89 ±0 .3[e]	10.69 ±0.11[e]	0.40 ±0.06[e]	1.22 ±0. 07[e]	80.20 ±0.70[a]
biscuit +5% WMSP	9.82 ± 0.10[b]	8.24±0.32[cd]	11.62±0.20[d]	1.55 ±0.08[d]	1.55 ±0.09[d]	78.59 ±0.62[b]
biscuit +10% WMSP	9.16 ± 0.13[c]	8.45±0.37[bc]	12.50± 0.19[c]	2.77 ±0. 35[c]	1.82 ±0.03[c]	77.23 ±0.44[c]
Biscuit+15%WMSP	8.99± 0.14[cd]	8.7±0.11[b]	13.41±0.14[b]	3.08 ±0.05[b]	2.21±0.06[b]	75.68±0. 25[d]
biscuit + 20% WMSP	8.61 ± 0.19[d]	9.11 ±0.12[a]	14.25 ±0.17[a]	4.47±0.06[a]	2.48 ±0.08[a]	74.16 ±0.28[e]
biscuit +5% GMSP	9.90 ± 0.11[b]	8.17 ±0.13[d]	11.58±0.33[d]	1.52±0.09[d]	1.44±0.10[d]	78.81 ±0.26[b]
biscuit +10% GMSP	9.33 ± 0.16[bc]	8.33 ± 0.33[c]	12.45±0 .15[c]	2.72 ±0.012[c]	1.73 ±0.05[c]	77.49 ±0. 54[c]
biscuit +15% GMSP	9.15± 0.14[cd]	8.59 ±0.18[b]	13.36±0.27[b]	3.05 ±0.09[b]	1.98 ±0.02[b]	76.07 ±0.14[d]
biscuit +20% GMSP	8.97±0.12[cd]	8.97 ±0.21[a]	14.11±0.012[a]	4.30 ±0.02[a]	2.33 ±0.9[a]	74.59 ±0.64[e]

Each value is an average of three determinations ± standard deviation.
Values followed by the same letter in columns are not significantly different at $P<0.05$.
WMSP :Watermelon seeds powder. GMSP: Gurma melon seeds powder. T. c. :total carbohydrates,

From the same Table, there were significant differences between control and substitution biscuits at different levels of WMSP and GMSP. in moisture content. The moisture contents ranged between 12.06 in control to 8.61 and 8.97 in substitution biscuits with 20 % WMSP and GMSP. The increased moisture content can be explained by the higher content of protein, which also increases the water binding capacity of dough with higher levels of WMSP and GMSP. It is also reported that the moisture content of biscuits increased with the addition of defatted maize germ biscuit flour (Farahat *et al.,* 2020). It is also apparent from the same Table that substitution of WMSP and GMSP to wheat flour leads to increased protein content from 7.89% in control to 9.11 and 8.97% in biscuit substitution with 20% WMSP and GMSP, respectively. The protein content of the substitution biscuits was increased by increasing the concentrations of substitution WMSP and GMSP. This increment may be due to the WMSP and GMSP's high protein content as compared to wheat flour. The current study's findings are consistent with those of Okudu and Ojinnaka (2018). Therefore, WMSP and GMSP had a tendency to improve the protein content of biscuits. On the other hand, it could be noticed that there were significant differences in the ether extract contents of the control and substitution supplemented biscuits.

Biscuit ash content ranged from 1.22% in control biscuits to 2.48% in substitution biscuits with 20% WMSP and GMSP. There were significant differences with higher values in the ash content of the biscuits substituted with WMSP and GMSP. Furthermore, ash content was decreased in the control, but ash content was significantly increased in the sample that was substituted with WMSP and GMSP. This increment may be due to the incorporation of WMSP and GMSP. The current study's findings are consistent with those of Peter-Ikechukwu *et al.,* (2020). The data in the same Table revealed that the crude fiber content of biscuits substituted with different levels of WMSP and GMSP was higher than that of the control sample. This might be due to the high fiber content in WMSP and GMSP as compared to wheat flour. Fiber content increased from 0.4% in control to 4.47 and 4.30% in biscuits containing 20% WMSP and GMSP, respectively. The variation in crude fiber content between the control sample and substitution biscuits with 5, 10, 15, and 20% WSF and GSF is highly significant. This is due to the high content of crude fiber. On the other hand, the total carbohydrate content in biscuit samples was significantly decreased by increasing WMSP and GMSP. It was decreased from 77.18% in control to 72.18% and 72.77% in biscuits substitution with 20% WMSP and GMSP. This is may be due to WMSP and GMSP are rich in protein and crude fiber. These results were in agreement with Kausar *et al.* (2020) who found that, biscuits supplemented with WMSP were more nutritious than the control.

3.7. Physical properties of biscuits

The physical estimations of biscuits made from different levels of WMSP and GMSP are displayed in Table (7). The results indicated that, the thickness and width of the biscuit were slightly increased with increasing substitution of WMSP and GMSP compared with the control biscuit. The maximum thickness (0.72 and 0.74 cm) and width (3.51 and 3.53 cm), were found at 20% WMSP and GMSP.while spread ratio of the biscuit was de creased with substitution of WMSP and GMSP compared with the control biscuit the maximum spread ratio (5.90 and 5.85) were found at 20% WMSP and GMSP.The results agree with work done by Kausar *et al.,* (2020) and Peter-Ikechukwu *et al.,* (2020).

Table 7: Physical properties of biscuit substitutions with different levels of WMSP and GMSP.

Samples	Thickness (cm)	Width (cm)	Spread Ratio
control biscuit	0.60 ± 0.04[c]	3.05 ±0.28[e]	5.08 ±0. 34[a]
biscuit +5% WMSP	0.62 ± 0.25[c]	3.21 ± 0.17[d]	5.18 ± 0.12[a]
biscuit +10% WMSP	0.66 ±0.04[bc]	3.33 ± 0.22[c]	5.05 ± 0.48[a]
biscuit +15%F WMSP	0.69± 0.02[b]	3.39 ± 0.12[b]	5.91 ± 0.24[ab]
biscuit +20% WMSP	0.72 ± 0.02[a]	3.51 ± 0.15[a]	5.86 ± 0.24[ab]
biscuit +5% GMSP	0.63 ± .05[c]	3.19 ±0 .14[d]	4.06 ± 0.35[a]
biscuit +10% GMSP	0.66 ± 0.06[bc]	3.33 ± 0.13[c]	5.05 ± 0.48[a]
biscuit +15% GMSP	0.68 ± 0.02[b]	3.39 ± 0.22[b]	5.99 ± 0.27[ab]
biscuit +20% GMSP	0.74 ± 0.02[a]	3.53 ± 0.17[a]	5.77 ± 0.24[ab]

Each value is an average of three determinations ± standard deviation.
Values followed by the same letter in rows are not significantly different at P<0.05.
WMSP: Watermelon seeds powder. GMSP: Gurma melon seeds powder.

3.8. Sensory characteristics of biscuit substitution with different levels of WMSP and GMSP

Table (8) shows the effect of substitution with different levels of WMSP and GMSP on the sensory evaluation of biscuits (appearance, texture, colour, flavour, and overall acceptability). Statistically, there were significant differences (p≤0.05) between control and substitution biscuits at different levels of WMSP and GMSP in the parameters evaluated. From the result in Table (8), it could be observed that the highest scores for appearance and texture were recorded in control biscuits (8.68 and 9.27), followed by substitution biscuits with 5% WMSP and GMSP. The lowest scores for appearance and texture were found in biscuit substitution, with 20% WMSP and GMSP. The results showed that texture was affected by an increase in substitution by WMSP and GMSP. This observation could be due to increased water absorption, which can result in a harder texture. The results of the sensory evaluation are similar to those of Peter-Ikechukwu *et al.,* (2020).

Table 8: Sensory characteristics of biscuit substitutions with different levels of WMSP and GMSP.

Samples	Appearance	Texture	Colour	Flavour	Over all acceptability
Control biscuit	8.68 ±0.24[a]	9.27±0.30[a]	9.42 ±0.59[a]	8.86±0.23[a]	9.06±0.49[a]
biscuit +5% WMSP	8.35 ±0.35[ab]	8.35±0.31[b]	8.90 ±0.34[b]	7.90±0.32[b]	8.37 ± 0.13[b]
biscuit+10% WMSP	8.29 ±0.22[ab]	8.00 ±0.24[b]	8.50 ±0.62[c]	7.70±0.17[bc]	8.12 ±0.21[bc]
biscuit +15% WMSP	8.15 ±0.31[b]	7.60 ±0.30[c]	8.25±0.33[cd]	7.45±0.20[c]	7.86 ±0.41[c]
biscuit+20% WMSP	6.40 ±0.24[c]	7.05 ±0.22[d]	8.10 ±0.36[d]	7.10 ±0.30[d]	7.16 ±0.18[d]
biscuit +5% GMSP	8.31 ±0.22[ab]	8.18 ±0.20[b]	8.89 ±0.22[b]	7.77±0.17[bc]	8.28 ±0.34b
biscuit +10% GMSP	8.25 ±0.20[ab]	7.88±0.31[bc]	8.40 ±0.22[c]	7.55 ±0.23[c]	8.02 ±0.33[bc]
biscuit +15% GMSP	8.05±0.16[b]	7.55 ±0.15[c]	8.20±0.17[cd]	7.34±0.21[cd]	7.78±0.49[c]
biscuit+20% GMSP	6.05 ±0.21[c]	7.00 ±0.18[d]	8.00 ±0.27[d]	7.00±0.24[d]	7.01±0.50[d]

Each value is an average of twenty determinations ± standard deviation.
Values followed by the same letter in columns are not significantly different at $p \leq 0.05$.
WMSP: Watermelon seeds powder. GMSP: Gurma melon seeds powder.

Colour is an important parameter in any type of food because it gives consumers a first impression and influences their acceptability (Caudillo *et al.,* 2008). From the results in this previousTable, it can be seen that significant differences were noticed in colour scores among the control sample and substitution biscuits with WMSP and GMSP. The higher score of colour was recorded in control biscuits (9.42), followed by substitution biscuits with 5% WMSP and GMSP. The lowest score of colour was found in biscuit substitution with 20% WMSP and GMSP (8.10 and 8.0). are similar to that of Kausar *et al.,* (2020). The higher score of flavour was recorded in control biscuits (8.86), followed by substitution biscuits with 5% WMSP and GMSP. The lowest scores of were found in biscuit substitutions with 20% WMSP and GMSP (7.1 and 7.0). These results were in agreement with Okudu and Ojinnaka (2018).Also, from the same Table, significant differences were noticed in the overall acceptability score among control samples and substitution biscuits WMSP and GMSP. The lowest overall acceptability score was found in biscuit substitution, with 20% of WMSP and GMSP. All samples were accepted. These results were in agreement with Okudu and Ojinnaka (2018) and Kausar *et al.,* (2020).

4. Conclusion

It is concluded that WMSP and GMSP can be utilized successfully for the preparation of biscuits with improved protein, fat, fiber and ash content until 15% without noticoble changes of sensory acceptability of final product.

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