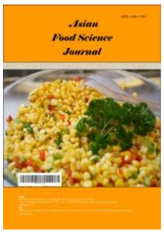

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Processing of a Nutrient-Rich Cereal Butter an Alternative to Peanut Butter

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Authors' contributions

This work was carried out in collaboration between both authors. Author TTELS managed some analysis of the study, wrote the protocol and wrote the first draft of the manuscript. Author JBA designed the study, managed the analysis of the study and performed the statistical analysis. Both authors read and approved the final manuscript.

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ABSTRACT

Cereal butter were made from sunflower, pumpkin, garden cress, corn, rye and peanut butter served as control. Chemical, physical, microbiological, textural and sensory evaluation of cereal based butter poduced from different types of cereal were analzed using a standard method. Pumpkin had highest protein (30.23%), while sunflower, pumpkin and peanut cereals had the highest amounts of fats (51.46, 49.05 and 48.00%, respectively). Also, corn had the highest amounts (72.56%) of carbohydrate. For microbiological evaluation, data show that total mould count ranged between 1.10 to 1.80 log cfu/g for rye and peanut, respectively. Garden cress is a good source of potassium, calcium, iron, and sodium. Also, Pumpkin is a good source of Magnesium, zinc, Phosphor and Selenium. Sunflower had the highest value of Vitamin B1, B2, B6, B9 and E but garden cress had the highest value of B2, K and C vitamins. The fatty acid composition of cereals reported that palmitic acid was the highest value in rye 21.80%. The Palmitoleic acid ranged from 0.22 to 12.50%, the lowest was peanut and highest occurred in sunflower. The highest of oleic acid was peanut 46.80%. Sunflower had highest Linoleic acid (69.0%) and garden cress had highest of linolenic acid 32.18%. Rye had highest value (20.69%) in Arachidic acid and garden cress scored highest in Eicosenoic acid (13.40%). The microbiological quality of cereals butter samples are total aerobic bacterial counts (TAB) ranged between 1.09 log cfu/g (rye butter) to 1.91 log cfu/g (peanut butter). Garden cress was obtained the higher for viscosity value (16100, 15900 and 15700 cp/s) at 25, 40, 60°C than other cereals butter. In texture

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analysis, garden cress butter had the highest significant amounts of hardness, cohesiveness, gumminess, chewiness and adhesiveness. Sensory evaluation of sunflower butter had the highest significant amounts of overall acceptability, peanut butter then pumpkin butter (96.30, 88.40 and 79.20, respectively) in all samples. Results could be useful in improving cereal butter processing and delivering sunflower butter to consumers who are more concerned as a functional food, high fat content and peanut allergy.

Keywords: Cereals butter; chemical; physical; microbiological; textural; sensory properties.

1. INTRODUCTION

Healthy cereal fats are supposed to lower cholesterol, blood pressure, and improve overall health. Some of these cereal fats are actually very helpful to maintain a healthy metabolism, ensure a healthy skin and also provide protection from heart diseases [1].

Essential fatty acids (EFA's) are essential because the body cannot synthesis them from any other substances, which means they can only be obtained from the food. They help to generate and maintain the fatty membranes, which coat every cell body. They are important for memory and brain function and they actively maintain healthy hair, skin and nails. There has been an abundance of research on these fatty acids and their activity in the human health [2].

Peanut butter is a food paste or spread made from ground dry roasted peanuts. It often contains additional ingredients that modify the taste or texture, such as salt, sweeteners or emulsifiers. Peanut butter is popular in many countries. Peanut butters and spreads are one of the most desired foods among the population ages 20 y and below. However, peanut consumption by children under the age of 3 is discouraged to prevent the development of peanut sensitivity to this product. Some people believed to be allergic to peanuts, with symptoms ranging from a mild case of hives to severe anaphylactic shock. Children make up a growing number of those allergic [3]. It's found that the rate of peanut and nut allergy among children increased. Sunflower butter may provide this segment of the population with an alternative product.

Sunflower (*Helianthus annuus L.*) is the one of the main crops used for edible oil production in many countries of the world, including Egypt [4]. Nutritive properties of sunflower butter are equivalent to those of peanut butter [5] with sunflower butter having 8 times more vitamin E and 4 times more iron. Sunflower seeds are a good source of protein, fiber, vitamin E, zinc and iron. They are also rich in alpha-tocopherols, which have been associated with a reduced risk of certain types of cancers. Additionally, the seeds contain phytosterols which may contribute toward lower levels of blood cholesterol [6].

Pumpkin seeds (*Cucurbita pepo* L.) are utilized directly for human consumption as snacks after roasting [7]. These seeds are an excellent source of protein, ranging between (25 - 37%), oil (37–45%) and are recognized as valuable high protein oil seeds for human consumption [8]. Total carbohydrate content ranges from 10% to 20%, while the moisture of around 5% is registered. Additionally, seeds contain considerable amounts of minerals such as magnesium, manganese and calcium, but only a low amount of copper. The presence of vitamins B, D, K and especially high level of A and C is also observed [9]. Pumpkins are widely grown for commercial use as food, aesthetics and recreational purposes [10]. Pumpkin seed oil contains fatty acids, such as oleic acid and alpha-linolenic acid [11]. Seeds of pumpkins can also be roasted as a snack and made into a paste that resembles peanut butter [12,13].

Garden cress (*Lepidium sativum* L.) popularly known as garden cress in English and chandrashoor in local language in India is a native plant of South West Asia which spread many centuries ago to Western Europe. It was used by the ancient Egyptians as a food source and became well known in various parts of Europe in due course, where it is still used as a minor crop. Garden cress seed is an important medicinal crop in India [14]. It also has a good anti – cancer potential [15]. Garden cress seeds have been known to be effective against a plethora of diseases ranging from diabetes mellitus, hypertension, kidney stones, inflammation, bronchitis, rheumatism and muscular pain. Its seed, oil and powder contain significant amount of protein, fat, minerals, fibers and phytochemicals, which are incorporated in many functional beverages and foods. It is rich in iron (100 mg/100 g) and also contains several nutraceutical components. Sarkar et al. [16] reported that garden cress seed is categorized under nuts and oil seeds. It contains good amount of lignans and antioxidants, which can stabilize the n-3 polyunsaturated fatty acids in its seed oil. Garden cress seed oil is a rich source of omega-3-fatty acids (30%) and natural antioxidant tocopherol (139 mg/100 g) and carotenoid (1.0 µg/100 g oil).

Maize (*Zea mays*), also known as corn, is a cereal grain first domesticated by indigenous peoples in southern Mexico about 10,000 years ago. Maize is the most important cereal crop after wheat, rice and barley in terms of production [17]. It is noteworthy too that the corn germ fraction also contains protein and consequently some high-oil corns tend to have slightly higher protein (and amino acid) level as well [18].

Rye kernel *(Secale cereale)* is a cereal grain which looks like wheat but is longer and more slender and its color varies from yellowish brown to grayish green. Rye has a very hardy, deep, nourishing taste. Rye is traditional bakery and pumpernickel breads. Rye flour usually retains a large quantity of nutrients. Hopefully more people discover rye's nutritional benefits and its unique taste profile, it will assume a more important role in our diets which have exceptionally high water-binding capacity and quickly give a feeling a fullness and satiety, making rye bread a real help for anyone trying to lose weight [19].

However, a small number of people with peanut allergies may also be allergic to sunflower seed butter. According to one study, a person with a known peanut allergy suffered an acute reaction to a "nut-free" butter containing sunflower seeds [20]. With regards to an increasing consumers' interest in healthy food, various nut and seed butters have recently become a novel, highly demanded food category. So, the aim of research is to evaluate the most common cereals, as well as, sunflower, pumpkin seed, garden cress, corn and rye for using different cereals in product cereal butter. The physical, chemical, microbiological and sensory qualities as well as the manufactured cereal butter characteristics were examined.

2. MATERIALS AND METHODS

2.1 Materials

Two imported cereals were obtained from U.S.A, High Oil Yellow Corn *(Zea mays*) and Rye *(Secale cereale)* and which were obtained from (Alexandria) Government. Egyptian cereals like Peanut *(Arachis hypogaea)* and Sunflower *(Helianthus annuus)* cereals were obtained from El-Bahara Government. While pumpkin *(Cucurbita sp.)* and Garden Cress (*Lepidium sativum*) seeds were obtained from Horticulture Research Institute. They were taken from three different sources since 2020. Media and reagents: the following solutions and media were used for mold enumeration and identification: Peptone water, Rose Bengal chloramphenical agar (Biolife, Italy).

2.2 Methods

2.2.1 Preparation of cereals

A ten kg of each cereal samples used in this investigation were stored at temperature 25°C and relative humidity less than 62% and taken samples from stores according to the methods described in [21]. Cereal samples were cleaned mechanically (Carter Dockage Tester, U.S.A and Regional Center for Food and Feed, Agriculture Research Central) to remove dirt, dockage, imparters and other strange cereals by Carter Dockage Tester according to the methods described in [22]. The samples were milled by Laboratory mill 3100 Perten according to the methods described in [23].

The cereal (Peanut, Sunflower, Pumpkin seed, Garden Cress, High Oil Yellow corn, and Rye) was heated at 100°C for 15 min and then cooled at room temperature to reduce its microbial load.

2.2.2 Process of cereal butters

Cereal butter were processed from milled samples according to [24]. The samples were blended in a food processor Braun®, Combimax K 650, Germany in speed 12 for 2min. Honey, salt and 8 g of each oil cereal was added to the same cereal samples and mixed for 7 min. Then, another 8 g of oil was added and mixed for 5 min; the rest 8 g of oil was added to the mixture and mixed for 5 min. The proper composition of the formulation for 100 g formula was 65 g cereal sample, 24 g oil, 1.5 g honey and 1.5 g salt.

Cereal butter were poured into sterilized glass jars, then autoclaved at 121°C/ 20 min, left to cool and stored at 25°C until analysis.

2.2.3 Analytical Methods

2.2.3.1 Physical properties

Cleanliness, dockage, splits, broken kernels, sound, foreign materials, total damaged kernels and total defects were separated and determined manually by hand picking. Test weight pound per bushel**,** Test weight P/B = (Kg ⁄ Hectoliter) ÷1.278 according to [25,26,27]. Hardness and thousand kernel weight was determined by counting the kernels in a 10 g of sample according to [23].

2.2.3.2 Chemical properties

Moisture, crude protein, vitamins, ash, crude fiber, amino acid, fatty acid, minerals and fat were determined according to [28] and cereals moisture according to [29]. Carbohydrate was calculated by difference. Estimation of Aflatoxins content, Ochratoxin, Zearalenone and Fumonisin were determined by HPLC according to the method [28].

Amino acid, vitamins and fatty acid were determined by HPLC according to the method [28] and minerals content (Mg, Zn, Ca, P, Cu, Mn, K, Na, Fe and Se) were determined using Atomic absorption spectrophotometer model 3300 Perken for element. The data were calculated as mg metal / 100 gm dry sample according to the method [28].

2.2.3.3 Microbiological properties

Total mold count and fungal identification were carried out using Rose Bengal chloramphenical agar and incubated for 5-7 days at 25°C. Fungal identification was performed for isolated fungi in Food Safety Lab, Regional Center for Food and Feed, Agriculture Research Center and identified according [30]. For the enumeration of Total aerobic bacteria (TAB), Yeast and Mould (YM) and Coliform Bacteria, samples of cereal butter (10 mg) were dispersed in 90 ml sterile Ringer’s solutions and appropriate decimal dilutions were prepared by using 1/4-strength Ringer’s solution under the aseptic conditions. Total count of TAB was enumerated by Plate Count Agar (Oxoid) after incubation at 37°C for 48 hours [31]. Coliform bacteria were enumerated on Violet Red Bile Agar (Oxoid) after incubation at 37°C for 24 h according to [32].

2.2.3.4 Texture measurements of cereal butter

Samples texture measurements of cereal butter were carried out with Universal Testing Machine, Cometech, B type, Taiwan provided with software according [33]. The texture measurement of each butter averaged from 5 replicates. Back extrusion cell with 35 mm diameter compression disc was used. Two cycles were applied, at a constant crosshead velocity of 1 mm/s, to 25% depth and then returned. From the resulting forced- time curve, firmness (N), cohesiveness, gumminess (N), chewiness (N), springiness, resilience and adhesiveness (Ns^{-1}) were calculated using the TPA graphic.

2.2.3.5 Viscosity of cereal butter

Viscosity was measured at 25, 40 and 60°C using the Brookfield rotational viscometer (model Brookfield DV- III ultra-programmable rheometer Brookfield Engineering Laboratories, INC., 11 Commerce Boulevard, Middleboro, USA) using No. 4 spindle at 20 rpm. Two readings were recorded for each sample according to [31].

2.2.3.6 Sensory evaluation of cereal butter

Cereal butters were orgaolpticaly evaluated according to the method described [23]. The fresh sample was delivered to 10 panelists 2 hours after cooking and cooling in refrigerator. The sensory evaluation of cereal butter was determined by the panelists to determine spreadability, texture, colour, flavour, taste and overall acceptability according to [23].

2.2.3.7 Statistical analysis

Data of three replicates were determined by Duncan's multiple range test at P=.05 level was used to compare between means according to SAS programs [34].

3. RESULTS AND DISCUSSION

3.1 Chemical Properties of Cereals

Chemical composition of different cereals used in this study was given in Table (1). Cereals moisture content of different varieties ranged from (5.80 to 10.2%) for all studied samples. Rye had the highest value while sunflower and pumpkin had lowest value among all samples. As regards protein content, Pumpkin had the highest protein (30.23%) followed by peanut (25.0%), while corn (8.0%) had the lowest protein content. Additionally rye was lower in fat content (2.30%) while corn was lower in ash content (1.40) than the other cereals. However, highest ash content was observed in garden cress (4.65%). The results of fiber showed that corn had lowest value (2.0%), on the other hand carbohydrates % ranged from 6.65% pumpkin to 72.56% corn, but total calorie values % ranged from 329.82% rye to 588.97% pumpkin. Mohammed [35], reported that the garden cress cereals contain 25% of protein, 14- 24% of lipids, 33-54% of carbohydrates and 8% of crude fiber. Garden cress observed the proximate chemical compositions the moisture 2.9%, crude protein 24.2%, crude fat 23.2%, carbohydrate 30.7%, crude fiber 11.9%, ash 7.1% [36]. This shows that both peanut, garden cress, rye and pumpkins cereals, pumpkin rind are suitable for incorporation into fiber rich food products. The results of nutritive status of *C. pepo* correspond to the determination results reported by [7,37,38].

3.2 Physical Properties of Kernels

Mean value of physical properties of different cereal are presented in Table (2). The statistical analysis for test in all samples can be concluded that the test weight ranged from 27.10 to 57.80 pound per bushel. Garden cress had highest value (57.80 p/b) in test weight (57.80 p/b) followed by rye (56.60 p/b), corn (56.50 p/b) and the lowest value (27.10 p/b) was sunflower. Data showed no significant differences between the foreign materials in all samples. The lower broken kernel was pumpkin (0.30%) and the higher was corn (1.10%). For damage kernels which contest all types of damage, especially peanut which had highest damage kernels percentage (0.50%), while pumpkin and garden cress had lowest percentage of damage kernels (0.10%). More over from the same table noticed that all sample are free from insect and odor was Ok. The statistical analysis for weight per 1000 kernels content was significantly different between all cereals which were ranged from 5.0 to 910.0 gm. The highest weight content noticed for peanut (910.0 gm), while garden cress (5.0 gm) had lowest weight content). Hardness of cereals was different from 60.0% to 78.20% for rye and peanut, respectively. The Egyptian stander no. 1601/1986 and it's modification on 23/4/2002 [39] has obligation that the dockage % (first separated from sample), and foreign material must not exceed 1%, while total damage kernels % (heat, sprout, insect and mould damage kernels) must not exceed 4%. However the differences between peanut and cereal samples had grade one according to [27,26,25].

3.3 Total Mold Count Log cfu/g and Mycotoxins Content of Cereals

Results in Table (3) reported the presence of Mycotoxin in cereals. It can be noticed that all samples had low mycotoxin content before storing under detection limit (0.5ppb) for aflatoxin, ochratoxin, zearalenone, fumonisin. Thus, it can be concluded that all sample content of aflatoxins were under detection limit (0.5ppb) of the Stander Egyptian maximum (B1=10ppb and total aflatoxin =20 ppb). Results of isolated fungal species for cereals are presented in Table (3). Data showed that total mould count ranged between 1.10 to 1.80 log cfu/g, peanut had highest and rye had lowest total mould count. This Standard is applied to be used for food and non-food purposes. Cereals division into types which represented indices, characteristics and quality norms of cereals according to classes; obligatory requirements for cereal, which guarantee human, animal, and environmental safety and health (condition, odor and color of grain, infectiousness), (toxic elements, mycotoxins and pesticides), (safety and industrial sanitation requirements) and (natural environment protection) approved [40].

Table 1. Proximate analysis of different kernels using for cereal butter

Cereals	Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Moisture %	7.20^{c}	6.20^{d}	5.80^{d}	7.30^{c}	8.40^{b}	10.2^{a}
Protein%	25.0^{b}	30.23^{a}	20.78^{c}	22.47^{c}	8.0^{e}	12.30^{d}
Fat %	48.0^{a}	49.05^{a}	51.46^{a}	27.48^{b}	7.64^{c}	2.30^{d}
Ash%	2.32^{bc}	2.10^{bc}	2.74^{b}	4.65^{a}	1.40^{c}	2.0^{bc}
Fiber%	9.0^{a}	6.0^{ab}	8.60^{a}	7.0^{ab}	2.0^{b}	8.22^{a}
Carbohydrate%	8.48^{d}	6.65^{d}	10.62^{d}	31.10^{c}	72.56^{a}	64.98^{b}
Total caloric values%	565.92^{a}	588.97^{a}	588.74^{a}	461.60^{b}	391.0^{c}	329.82^{d}

a,b,…Means with the same letter in the same row are not significantly different at P=.05

Table 2. Physical properties of different kernels using for cereal butter

Cereals	Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Test Weight p/b	33.0^{b}	30.0^{bc}	27.10^{c}	57.80^{a}	56.50^{a}	56.60^{a}
Foreign Materials%	0.30^{a}	0.10^{a}	0.10^{a}	0.10^{a}	0.50^{a}	0.40^{a}
Broken kernels%	-	0.30^{b}	-	-	1.10^{a}	-
Broken and Splits%	1.50	-	-	-	-	-
Thin%	-	-	-	-	-	0.72
De hulled Seeds %	-	0.01^{a}	0.03^{a}	-	-	-
Damage Kernels%	0.50^{a}	0.10^{d}	0.20^{cd}	0.10^{d}	0.30^{bc}	0.33^{b}
Odor	Ok	Ok	Ok	Ok	Ok	Ok
Insect	Free	Free	Free	Free	Free	Free
Grade	1	1	1	1	1	1
Weight per 1000 kernels gm	910.0^{a}	170.4^{c}	110.35^{d}	5.0^{f}	387.0^{b}	24.10^{e}
Hardness%	78.20^{a}	69.0^{b}	66.0^{b}	68.9^{b}	61.0^{b}	60.0^{b}
Colour	Yellow	Creamy	Black	Red	Yellow	Beige

a,b,…Means with the same letter in the same row are not significantly different at P=.05. p/b= Pound per Bushel (American unit)

Table 3. Mycotoxins content and Total Mold count log cfu/g of different cereals using for cereals butter

Cereals		Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Ochratoxin ppb		*	*	*	*	*	*
Zearalenone ppb		*	*	*	*	*	*
Fumonisin ppb		*	*	*	*	*	*
Aflatoxin ppb	B1	*	*	*	*	*	*
	B2	*	*	*	*	*	*
	G1	*	*	*	*	*	*
	G2	*	*	*	*	*	*
	Total	*	*	*	*	*	*
Total Mold count log CFU/g		1.80^{a}	1.56^{ab}	1.30^{ab}	1.20^{b}	1.60^{ab}	1.10^{b}

***=** *Under detection limit (0.50 ppb); a,b,…Means with the same letter in the same row are not significantly different at P=.05*

3.4 Minerals for Different Cereals

Minerals for different cereals in Table (4) can be noticed that (Mg) ranged from 2.68 to 447.0 mg/100 g for all samples, where pumpkin had the highest Mg (447.0 mg/100 g) followed by sunflower and rye which have the lowest Mg (2.68 mg/100g). But for (Zn) which ranged from 3.30 to 5.94 mg/100g for all samples. Pumpkin had the highest Zn (5.94 mg/100 g) and peanut with lowest Zn (3.30). Moreover it can be observed that some micro element have the highest range of K (1789.49 mg/100 g) for garden cress, P (935.5 mg/100g) for pumpkin, Cu (4.01 mg/100 g) for corn, Mn (121.0 mg/100 g) for rye and Ca for garden cress (198.50). Moreover it can be observed that the highest Fe in all samples is garden cress (16.30 mg/100 g) and the lowest is peanut (2.0 mg/100 g). While the highest value of Na is garden cress (104.52 mg/100 g) and the lowest one is corn (3.0 mg/100 g). Data showed no significant differences between (Se) content in all samples. These results agree with result obtained by [41]. These results show that the macronutrients are considerably high and suitable for human nutrition. In addition, the above findings are almost in accordance with the outcomes reported by [36,35,42]. Garden cress seeds possess fair levels of protein (21-25%), fat (23-27%), carbohydrate (30-34%), dietary fiber (30%), phosphorus (723 mg/100 g), magnesium (430 mg/100 g), calcium (296-377 mg/100 g), iron (76-100 mg/100 g), zinc (5 mg/100 g) and thus an important nutraceutical seed for nutrient enrichment [43]. Garden cress seed has the potential for providing essential nutrients for human and other animals, as the nutritional activity of any plant is usually related to the particular elements it contains [44]. With these minerals content, it can be utilized for the development of a number of supplementary food products.

3.5 Vitamins for Different Cereals Butter Made of Different Cereals

Vitamins of different cereals used in this study are given in Table (5). Thiamine (B_1) of cereal butter ranged from (3.8 to 129.0%). Sunflower had the highest value while corn had lowest value among all samples. As regards Riboflavin (B_2), corn (1.40%) had the lowest (B_2). On other hand Niacin (B3) % ranges from 7.0% (garden cress) to 86.0% (peanut). Additionally, garden cress was lower in Pantothenic (B_5) (5.0%) than other samples and pumpkin was lower in Pyridoxine (B_6) (11.0%) in completely in other grains. As regards, Peanut and sunflower had the highest in Folic Acid, while pumpkin and sunflower had highest in Vitamin E. But garden cress had the highest in Vitamins k and C, while corn (1.0%) had the highest in Vitamin (A) in all samples. Sunflower is one of the richest sources of B-complex vitamins. Very precisely these are very good sources of niacin, folic acid, thiamin (vitamin B1), pyridoxine (vitamin B6), pantothenic acid, and riboflavin [45]. Garden cress seed also contains sufficient amount of vitamins, mainly thiamine (0.59 mg), riboflavin (0.61 mg) and niacin (14.3 mg). These vitamins work as a co-factor and help in body metabolism [46]. These results agree with result obtained by [47,48] and recommended by [49].

3.6 Amino Acids for Different Cereals Butter Made of Different Cereals

The statistical analysis for amino acids in different cereals cultivars used is given in Table (6). Aspartic acid of different cereals ranged from 2.48 to 10.33 g/100g for all samples. Sunflower had significant highest value while pumpkin had lowest among all samples. Alanine acid ranged from 1.0 to 7.80 g/100 g, where corn had the highest and peanut and pumpkin had lowest values among all samples.

Data showed no significant differences between the arginine of different cerelas in studied samples. As regards Cystine, corn had the highest value (2.50 g/100 g), while rye had the highest value of glutamic (23.7 g/100 g). At the same trend with glycine, garden cress had the highest value (5.51 g/100 g) while corn had highest value of leucine among all samples (13.70 g/100 g), respectively. On other hand lysine ranged from 0.90 g/100 g (peanut) to 6.26 g/100g (garden cress). Additionally, garden cress was higher in histidine (3.87 g/100 g), isoleucine (5.11 g/100 g), phenylalanine (5.65 g/100 g) and valine (8.04 g/100 g. Rye and corn had highest significant value of proline (8.90, 8.40 g/100 g), but corn was the highest in serine and threonine (5.70 g/100 g) and (4.0 g/100 g), respectively. However, rye had the highest value of tryptophan (2.2 g/100 g). The most abundant amino acid in garden cress protein is glutamic acid (19.3%) and among the essential amino acid, leucine, is the highest (8.21%) and methionine, is the lowest (0.97%) [42]. From these results, garden cress was the highest value in a lot of amino acids among all samples. These results agree with result obtained by [48] and recommended by [49].

Table 4. Minerals content of cereals butter made of different cereals

Minerals mg/100g	Cereals					
	Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Mg	184.0^{d}	447.0^{a}	325.0^{b}	268.0^{c}	37^{e}	2.68^{f}
Zn	3.30^{b}	5.94^{a}	5.0^{ab}	3.75^{ab}	4.60^{ab}	3.73^{ab}
K	332.0^{c}	652.60^{b}	645.0^{b}	1789.49^{a}	27.0^{e}	264.0^{d}
P	336.0^{e}	935.50^{a}	660.0^{b}	535.49^{c}	89.0^{f}	374.0^{d}
Cu	-	1.35^{bc}	-	3.23^{ab}	4.0^{a}	0.45^{c}
Mn	2.0^{c}	3.44^{c}	1.95^{c}	1.88^{c}	37.0^{b}	121.0^{a}
Ca	62.0^{c}	37.67^{d}	78.0^{b}	198.5^{a}	0.10^{e}	33.0^{d}
Fe	2.0^{b}	6.81^{b}	5.25^{b}	16.30^{a}	6.10^{b}	2.67^{b}
Na	6.0^{bc}	5.50^{bc}	9.0^{b}	104.52^{a}	3.0^{c}	6.0^{bc}
Se	-	0.009^{a}	-	-	0.008^{a}	0.035^{a}

a,b,…Means with the same letter in the same row are not significantly different at P=.05

Table 5. Vitamins content of cereal butter made of different cereals

Vitamins %	Cereals					
	Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Thiamine (B_1)	52.0^b	23.0^c	129.0^a	7.0^d	3.8^d	18.0^c
Riboflavin (B_2)	25.0^a	12.0^b	30.0^a	22.0^a	1.4^c	22.0^a
Niacin (B_3)	86.0^a	31.0^c	56.0^b	7.0^d	28.0^c	12.0^d
Pantothenic acid (B_5)	36.0^b	15.0^c	23.0^c	5.0^d	66.0^a	-
Pyridoxine (B_6)	23.0^c	11.0^d	103.0^a	19.0^{cd}	53.0^b	-
Folic Acid (B_9)	62.0^a	15.0^b	57.0^a	20.0^b	3.0^c	4.3^c
Vitamin E	44.0^b	237.0^a	234.0^a	5.0^d	24.0^c	-
Vitamin K	-	-	-	516.0^a	-	1.0^b
Vitamin C	-	3.0^b	2.0^{bc}	83.0^a	-	-
Vitamin A	-	0.50^b	-	-	1.0^a	-

a,b,…Means with the same letter in the same row are not significantly different at P=.05

Table 6. Amino acids content of cereal butter made of different cereals

Amino acids g/100 g	Cereals					
	Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Aspartic	3.06^{bc}	2.48^c	10.33^a	9.79^{ab}	6.80^{abc}	7.2^{abc}
Alanine	1.0^b	1.16^b	4.10^{ab}	4.83^{ab}	7.80^a	4.4^{ab}
Arginine	3.0^a	4.03^a	6.97^a	4.51^a	4.80^a	4.9^a
Cystine	0.32^c	0.30^c	1.48^b	-	2.50^a	1.7^b
Glutamic	5.24^c	4.32^c	13.98^b	19.33^{ab}	17.70^{ab}	23.7^a
Glycine	1.51^c	1.80^c	4.13^b	5.51^a	4.20^b	4.5^b
Leucine	1.62^c	2.08^c	6.70^b	8.21^b	13.70^a	5.9^b
Lysine	0.90^e	1.83^{de}	4.91^b	6.26^a	2.80^{cd}	3.8^c
Methionine	0.31^c	0.55^c	1.22^{bc}	0.97^{bc}	1.90^{ab}	2.9^a
Histidine	0.63^c	0.68^c	2.49^b	3.87^a	2.90^{ab}	2.3^b
Isoleucine	0.88^d	1.26^d	4.02^b	5.11^a	3.90^b	3.3^c
Phenylalanine	1.3^d	1.22^d	5.05^b	5.65^a	5.40^a	4.0^c
Proline	1.11^d	1.0^d	3.13^c	5.84^b	8.40^a	8.9^a
Serine	1.24^d	1.15^d	4.04^c	4.96^b	5.70^a	4.2^c
Threonine	0.86^c	0.90^c	2.52^b	2.66^b	4.0^a	3.7^a
Tryptophan	0.25^{cd}	0.43^c	-	-	0.90^b	2.2^a
Tyrosine	1.02^b	1.02^b	3.0^a	2.69^a	3.40^a	1.5^b
Valine	1.05^b	1.97^b	4.39^{ab}	8.04^a	5.0^{ab}	3.3^{ab}

a,b,…Means with the same letter in the same row are not significantly different at P=.05

3.7 Fatty Acids for Different Cereals butter Made from Different Cereals

The fatty acid profile presented in Table (7) show that the cereals has 7 important fatty acids with various percentages. The major fatty acids present were palmitic, stearic, elaidic, oleic, linoleic, arachidic and eicosenoic acids. The fatty acid composition of cereals reported in this study revealed that palmitic acid content was as low as 6.44% corn and rye was as high as 21.80% in all samples. Palmitic acid is the most abundant saturated fatty acid while palmitoleic acid is the least abundant unsaturated fatty acid [50]. The palmitoleic acid ranged from 0.22 to 12.50%, the lowest was peanut and the highest was sunflower. Palmitic acid is an ionic surfactant, which has a pleasing sensation to the body. It is thus mainly used to produce soaps, cosmetics and releasing agents. Palmitic acid is the commonest saturated fatty acid in the plants and animal lipids. Palmitic acid helps to control obesity and helps to recover some reproductive abnormalities [51]. It is reported that the diet enriched with palmitic acid is good for diabetes [52]. The stearic acid was found from 1.90 to 12.50% and the highest was sunflower. Stearic acid is commonly used in the manufacture of soaps, detergents, shampoo, shaving creams and other cosmetic products. It is one of the most common saturated fatty acids found in the nature following palmitic acid [53]. Butter rich in stearic acid is solid at room temperature. It is also used in many food products because it remains stable at high temperatures. It is commonly used in margarine and other spreads. It is reported that the total plasma cholesterol decreased by an average of 14% during the consumption of high stearic acid diet [54]. Peanut is highly oleic acid (46.80%) and rye was the lowest (5.14%) for all samples. Higher intake of oleic acid is associated with decreased risk of coronary heart disease caused by high cholesterol level in blood [50]. High oleic acid makes the butter less susceptible to spoilage, so could be useful in food preservation. Oleic acid may hinder the progression of adrenoleukodystrophy, a fatal disease that affects the brain and adrenal glands [55]. Oleic acid may be responsible for the hypotensive effects of olive oil [56]. Sunflower had highest Linoleic acid (69.0%) and garden cress (32.18%) of linolenic acid. Linoleic acid is another important acid which is present with a moderate percentage (5-11%). The use may include, helping people loose body fat [57] and possibly preventing colon or breast cancer [58]. It is a strong antioxidant with benefits such as lowering high cholesterol and controlling weight. Rye had highest arachidic acid (20.69%) and garden cress was highest in eicosenoic acid (13.40%). Arachidic acid (1-8%) is a saturated fatty acid. It is a minor constituent of peanut oil (1.1-1.7%) and corn oil (3%). Arachidic acid is used for the production of detergents, photographic materials and lubricants. The food rich with arachidonic acid is known as anti-inflammatory diet [59]. The fatty acid composition of garden cress is interesting from the nutritional point of view for their higher contents of unsaturated fatty acids especially omega three fatty acid which is beneficial for health [50].

3.8 Microbiological Analysis of Cereals Butter made from Different Cereals

The microbiological quality of cereal butter samples is shown in Fig. (1). Total aerobic bacterial counts (TAB) ranged between 1.09 log cfu/g (rye butter) to 1.91 log cfu/g (peanut butter). Similar data of counts were observed in the total count of samples refer [60]. In addition, no coliform or yeasts and moulds were recovered from any of the milk samples (i.e. 10^{-1} dilution). Yeast, moulds and coliform bacteria were not found from any research samples within the first dilution analysis, this indicating no contamination in raw materials or during the manufacturing process.

3.9 Viscosity of Cereals Butter Made Different Cereals

The flow curve (viscosity) of reduced fat cereals paste/date syrup blend contain at 25, 40 and 60°C is shown in Fig. (2). Garden cress was high viscosity at 25, 40 and 60°C, as compared with other cereals butter (16100, 15900 and 15700 cp/s), respectively. The shear stress-shear rate relationship of fat cereal paste/date syrup blend for all fat replacers, fat substitution levels, and temperatures (24, 40 and 60°C) reported nonlinear, indicating that the cereals paste/date syrup blends behave as a non-Newtonian fluid [61]. It was concluded that high pH, low water, seed ratio and mild extraction temperatures will give a high viscosity for *L. sativum* extract. It decides the flow behavior of the products and is considered much during the formulation of any liquid or semisolid products. In [62] determined that the viscosity of grains butter was decreased with increasing heat treatments. Also, [63] reported that the viscosity of different samples of wheat, barley, soya beans, Rye and oats vary considerably, and that the viscosity values are affected by heat treatment which pointed out that there is a relationship between the water binding capacity, heat treatment and the viscosity of the product. Also, [64] explained the reason for arabinoxylans and β-glucans are the two most important water-extractable dietary fiber polysaccharides in cereal food products and its determined their physical properties like viscosity, extractability, solubility and gelling behavior, as well as nutritional properties. The reduction of gum viscosity with temperature might be the result of irreversible change in molecular conformation [65].

3.10 Texture Profile Analysis (TPA) for Different Cereals Butter made Different Cereals

Texture profile analysis (TPA) of cereals butter in Table (8) indicated that, sunflower and corn butter were lesser significantly effect on hardness than the other cereals butter while sunflower butter cohesiveness was similar to garden cress butter and corn in high significantly of the other treatment. Cohesiveness is defined as the strength of the internal bonds within the body of the product [66] suggesting that the internal bonds of the flour; Sunflower and garden cress butters were stronger than control peanut butter, Pumpkin and rye, respectively. For gumminess, chewiness and adhesiveness, garden cress butter received the greatest average reading, which is more significant gummy, chewy and adhesiveness than all other treatments. Corn butter received the least value of gumminess, chewiness and adhesiveness compared to control peanut butter and other cereals. This is because both, gumminess and chewiness are parameters dependant on firmness; therefore, their values, followed a similar trend that of hardness [67]. Since the most important characteristic of nut spread is spreadability, it is of utmost importance that the product should have a soft texture and be easily spreadable to avoid tearing the bread or crumbling the crackers [68].

3.11 Sensory Evaluation of Cereals Butter made of Different Cereals

Sensory evaluation of cereals butter samples had significant differences were observed in spreadability, texture, colour, taste, flavor and overall acceptability. Data in Table (9) showed the sensory evaluation of cereals butter made from different cereals. It can be noticed that, sunflower butter had highest mean score of spreadability and taste (19.1) and (19.0) while lowest score was recorded in spreadability, taste (10.0) and (10.0) garden cress butter considering as least acceptable. Garden cress obtained the least score (7.0) for texture whereas sunflower butter received the highest score (19.40). Highest mean score for colour (19.20) were obtained by sunflower butter. The low score of garden cress butter may be due to high fiber and ash content, which affect the colour of cereal since consumers prefer creamy colour and not dark cereal butter. In case of flavor, Sunflower butter was at the top (19.60) followed by peanut butter (18.20) and Pumpkin butter (18.0). Maximum appearance score (20.0) were attained by sunflower butter while garden cress butter received the minimum score (10.0). For total scores, sunflower butter pudding had highest total scores, followed by control peanut butter then pumpkin butter 96.30, 88.40 and 79.20% respectively. The differences in colour, spreadability and flavour of all the cerealsbutter were attributed to the differences of cereals and other factors like varieties and characteristics of cereals. It could be concluded that garden cress have significant content of microelements, nutritional activity along with excellent functional characteristics, but garden cress butter thus considered least acceptable which can be used as a food supplement and functional agent. With a high protein and physicochemical characteristics similar to those cereals, the used cereal can be considered as a new and valuable source of edible butter.

Table 7. Fatty Acids content of cereal butter made of different cereals

Fatty Acids %	Cereals					
	Peanut	Pumpkin	Sunflower	Garden cress	Corn	Rye
Palmitic (C16:0)	10.0^{c}	10.68^{c}	12.50^{b}	10.30^{c}	6.44^{d}	21.8^{a}
Palmitoleic (C16:1)	0.22^{cd}	0.58^{bc}	12.50^{a}	0.70^{b}	-	-
Stearic (C18:0)	5.76^{c}	8.67^{b}	12.50^{a}	1.90^{d}	6.27^{c}	2.52^{d}
Oleic (C18:1)	46.80^{a}	38.42^{b}	20.0^{e}	30.50^{c}	27.30^{d}	5.14^{f}
Elaidic (C18:1 trans-9)	-	-	-	-	0.81	-
Linoleic (C18:2)	33.40^{d}	39.84^{c}	69.0^{a}	8.60^{e}	58.0^{b}	56.1^{b}
Linolenic (C18:3)	0.48^{c}	0.68^{c}	0.10^{d}	32.18^{a}	3.0^{b}	-
Arachidic (C20:0)	0.58^{c}	-	-	2.10^{b}	0.27^{d}	20.69^{a}
Eicosenoic (C20:1)	0.15^{c}	-	-	13.40^{a}	-	2.06^{b}
Gadoleic (C20:1 n-11)	-	1.14^{a}	-	-	0.93^{a}	-
Behenic (C22:0)	-	-	-	-	1.29^{a}	1.37^{a}
Erucic (C22:1)	-	-	-	-	-	11.47
Lignoceric (C24:0)	-	-	-	-	-	4.32

a,b,…Means with the same letter in the same row are not significantly different at P=.05

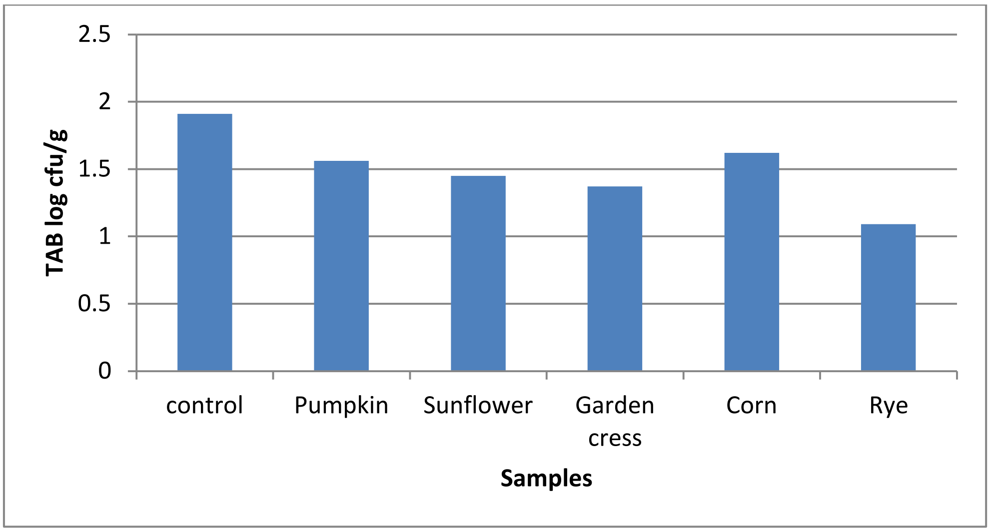

Fig. 1. Microbial counts log cfu/g of cereal butter made from different cereals

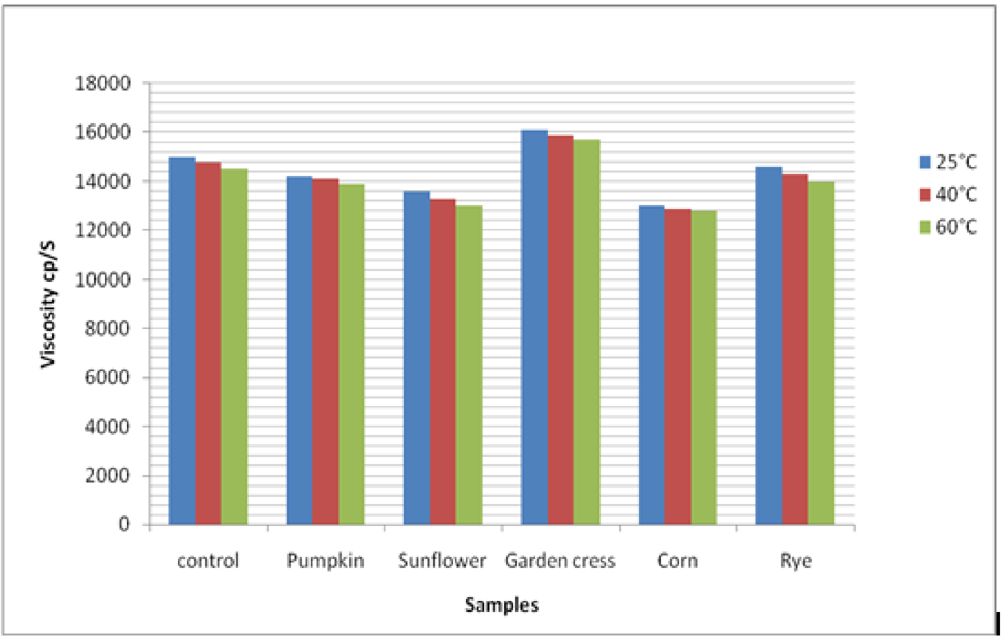

Fig. 2. Viscosity of cereal butter made of different cereals at (25- 40- 60) °C

Table 8. Texture profile properties of cereal butter made of different cereals

Cereal butter	Hardness (N)	Cohesiveness	Gumminess (N)	Chewiness (N)	Adhesiveness (Ns^{-1})
Peanut	2.22^{a}	0.58^{b}	1.19^{b}	0.92^{ab}	2.59^{c}
Pumpkin	2.30^{a}	0.54^{b}	1.25^{b}	0.94^{ab}	2.87^{c}
Sunflower	1.13^{b}	0.85^{a}	0.96^{c}	0.81^{ab}	3.39^{b}
Garden cress	2.96^{a}	0.82^{a}	1.69^{a}	1.64^{a}	3.81^{a}
Corn	1.18^{b}	0.81^{a}	0.72^{d}	0.48^{b}	1.34^{d}
Rye	2.21^{a}	0.53^{b}	1.16^{b}	0.82^{ab}	2.59^{c}

a,b,…Means with the same letter in the same colum are not significantly different at P=.05

Table 9. Sensory evaluation of cereal butter made different cereals

Cereal butter	Spreadability 20	Texture 20	Colour 20	Flaver 20	Taste 20	Overall 100
Peanut	18.20[ab]	18.20[ab]	18.20[ab]	18.20[ab]	15.60[b]	88.40[ab]
Pumpkin	16.0[abc]	16.40[abc]	16.0[ab]	18.0[ab]	12.80[c]	79.20[bc]
Sunflower	19.10[a]	19.40[a]	19.20[a]	19.60[a]	19.0[a]	96.30[a]
Garden cress	10.0[d]	7.0[d]	10.0[c]	10.0[d]	10.0[d]	47.0[d]
Corn	15.0[bc]	15.0[bc]	15.0[b]	14.0[c]	13.0[bc]	72.0[c]
Rye	13.0[cd]	14.0[c]	15.0[b]	15.0[bc]	13.0[bc]	70.0[c]

a,b,…Means with the same letter in the same colum are not significantly different at P=.05

4. CONCLUSION

The cereals butter prepared from pumpkin, sunflower, garden cress, corn and rye cereals were compared to control peanut butter, in terms of nutritional, microbiological, physical, chemical, textural and sensory values. Sunflower had the highest sensory score, while garden cress butter had the lowest one. Results of this study could be used sunflower butter as alternative for peanut butter the best of all cereals butter. Besides that adding a value to who are concerned about new cereals and it's butter as an important functional food, high- fat content and peanut allergy.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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