الصفات الحسية والبيوكيميائية لبعض منتجات المخابز المدعمة ببذور السمسم منزوعة الدهن

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المستخلص :

يعتبر السمسم ***Sesamum indicum*.L** من المحاصيل الهامة اقتصاديًا في جميع أنحاء العالم وهو المحصول الزيتي الرئيسي في المملكة العربية السعودية. كان الهدف من هذه الدراسة هو تقييم الجودة التغذوية وقبول المستهلك للبسكويت المنتج من خليط من دقيق القمح ***Triticum aestivum*** ودقيق السمسم منزوع الدهن **(DSF)**. تمت إضافة دقيق السمسم منزوع الدهن (DSF) بمستويات مختلفة من الإحلال ١٠ و٢٠و٣٠٪ الى دقيق القمح (٧٢%) لصناعة البسكويت. وتم فحص الصفات الفيزيائية والكيميائية والحسية لعينات البسكويت الناتج باستخدام الطرق القياسية، وخلصت النتائج إلى أن استبدال دقيق السمسم منزوع الدهن بنسبة ٢٠٪ كان الافضل من حيث الخصائص الحسية للبسكويت الناتج من اللون والطعم والمظهر والنكهة والقوام والقبول العام. بالإضافة إلى ذلك أظهر المحتوى البروتيني والألياف والرماد في البسكويت الناتج زيادات بينما حدث الانخفاض في محتويات الكربوهيدرات والرطوبة كما زاد من محتوى العناصر المعدنية في البسكويت الناتج مع زيادة نسب دقيق السمسم منزوع

الدهن. ففي حين كان البسكويت المحتوي على ٣٠٪ استبدال أقل قبولا لذلك فإن استخدام ٢٠٪ من دقيق السمسم منزوع الدهن في صناعة البسكويت يعمل على تحسين المحتوى الفيزيائي والكيميائي والمغذيات الدقيقة للبسكويت الناتج.

الكلمات المفتاحية: بسكويت، دقيق سمسم منزوع الدهن، استخلاص ميكانيكي التقييم الحسي.

BIOCHEMICAL AND SENSORY QUALITIES OF BISCUIT ENHANCED WITH DEFATTED SESAME SEEDS (*Sesamum indicum* Linn)

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ABSTRACT

Sesame (***Sesamum indicum***, **L.**) is considered as one of economically important crop over the entire world and it is the main oil seed crop cultivated in Saudi Arabia. The aim of this study was to evaluate the nutritional quality and consumer acceptability of composite biscuits produced from blends of wheat flour (***Triticum aestivum***) and defatted sesame flour (**DSF**). Wheat flour supplemented with defatted sesame flour (**DSF**) was added with different levels of substitution 10%, 20% and 30% for biscuit. The physicochemical and sensory attributes of the composite biscuit samples were investigated using standard methods. The results concluded that, 20% of defatted sesame flour **(DSF**) substitution was the best one of sensory characteristics of biscuits as color, taste, appearance, flavor, texture and overall acceptability. In addition, the protein, fiber, ash of the composite biscuit showed increases while the carbohydrates and moisture contents exhibited decreases in content. The mineral elements content of the composite biscuit increased with increased defatted sesame flour substitution. Composite biscuit with 30% substitution exhibited the least preference. Therefore, defatted sesame flour inclusion in biscuit making could improve the physicochemical and micronutrient contents of the composite samples.

Keywords: Biscuits, defatted sesame flour, mechanical extraction

sensory evaluation.

INTRODUCTION

Sesame seeds (***Sesamum indicum***) are tiny, flat oval seeds with a nutty taste. It is an important oil seed believed to have originated from tropical Africa with the greatest diversity (**RMRDC, 2004**). Sesame is mainly produced in Africa (3.0 million t) and Asia (2.3 million t). India, Sudan, China, Myanmar, and Tanzania account for 80% of the world production. China, India, Taiwan, Vietnam, and Mexico are the main users (**FAO, 2016**).

The proximate chemical composition of sesame seeds (***Sesame indicum***) indicates that it has significant amounts of proteins that can be used to produce composite flour with improved protein content for bread production. In addition, sesame has been reported to be a good source of calcium, magnesium, iron, phosphorus, zinc, copper, manganese, selenium, molybdenum, vitamin B1 and dietary fiber. Sesame seeds also contain lignans (sesameol and sesamolin) with cholesterol lowering effect, ability to prevent high blood pressure, protect the liver from oxidative damage and increase vitamin E supplies in humans (**Quasem *et al*., 2009** and **Pathak *et al*., 2014).**

Functional properties of baked goods can be improved through the introduction of the products of processing to their formulations, specifically oil-bearing crops, particularly sesame seeds **(Shcherbakov, 1991)**. The proteins of sesame seeds are characterized by its high biological value. They are rich in methionine and tryptophan. However, the proteins of sesame seed are limited for lysine, albeit to a lesser extent than the proteins of wheat **(Al’van *et al*., 1998)**. The fat-free flour from sesame seeds, obtained after extraction oil, is used to receive the isolates, and concentrates of sesame proteins. Thus, it may be a prerequisite for use sesame seeds in the production of bakery products for special purposes. This meal or cake has high alternative use as ingredients or protein source for food industries spatially in dough as biscuits, bread, and cakes. Increased mineral contents and protein for quality and availability is often achieved by increasing the ratio of wheat grain with different supplementations (**Tyagi *et al.*, 2006**).

The term biscuit defines a flat crisp baked product, chemically leavened, ready to eat, quick snacks with good eating quality and long shelf life. The elementary composition of biscuits includes flour, sugar, and fat (**Singh *et al*., 1993).** Biscuits are widely consumed between children with good taste and price. It is easily fortified with different types of micronutrients such as proteins, vitamins, and minerals to provide convenient food. Efforts are being made to improve the nutritive value of biscuits and functionality by modifying their composition (**Tyagi *et al.*, 2006**). Among all snack foods, biscuits form the most popular snack item and offer certain advantages such as cheaper than conventional snack items, easy to use during travel or at home, because of their availability in varieties of convenient pack sizes and longer shelf life (**Crassina *et al*., 2012**).

Biscuits have become one of the most appropriate snacks for elderly and young due to many reasons such as, low price, more convenience and ability to serve as a vehicle for important micronutrients **(Hooda and Jood 2005).** Biscuits are rich in fats, carbohydrates, but low in vitamins, fiber, and minerals which make it unhealthy food for routine use **(Ahmad and Ahmad, 2014).**

Biscuits are convenient food products and the most popular bakery items consumed by nearly all levels of society in Egypt. Some of the reasons for such wide popularity are the low cost among other processed foods (affordable cost), good nutritional quality and availability in different varieties, varied taste, easy availability, and longer shelf-life. Most bakery products are used as a source for incorporation of different nutritionally rich ingredients for their diversification

(Sudha *et al.,* 2007). Biscuits are a type of cookies with cereals as a basic component, and a rich source of protein and fat, carbohydrate, mineral, and energy giving foods **(Lourencetti *et al.*,2013).** In the structure of biscuits there is large number of raw materials, different improvers, and other additives, therefore they differ in: type, structure, mass, consistence, structure, and technology of production **(Conova and Karađov, 2013).**

Biscuit making is generally done from refined wheat flour of 60 to 75% extraction in which the major portion of minerals, vitamins, fibers found in the bran layer is partially or totally removed. This has significant effects on consumer's health if it is consumed heavily without supplementing with other foods rich in fiber, because dietary fiber is associated with various health benefits like lowering of cholesterol, glycemic index level, colon cancer, and bowel disorders and to improve lipid metabolism **(Izydorczyk and Dexter,2008).** Among confectionery products, biscuits can serve as a vehicle for important nutrients. Earlier, many authors have used protein and fiber rich ingredients to improve the nutritional quality of biscuits **(Abu Salem *et al*. ,2011 and Nandeesh *et al*., 2011);** partial substitution of wheat flour with defatted soybean or chickpea flours **(Saleh *et al.* 2012)**, oat, wheat, rice, and barley bran **(Sudha *et al*., 2007),** chickpea, broad bean, and isolated soy protein **(Rababah *et al*. ,2006).**

Therefore, the present study has been carried out to produce biscuit supplemented with defatted sesame meal with good quality (physical properties, sensory characteristics, and nutritional profile).

MATERIALS AND METHODS

Materials:

Defatted sesame meal (*Sesamum indicum* L.) was obtained from Al-Awara factory at Tanta city, while wheat flour (72% ext.) was purchased from a local market (Tanta city, Egypt). Defatted sesame meal was supplemented by 0, 10, 20 and 30 % of wheat flour. The flour mixtures were individually blended, homogenized, packed in polyethylene bags, tightly closed, and stored at low temperature in freezer (-20°C) until utilized.

The other materials used in preparation of biscuits i.e., salt, skim milk powder, eggs (whole fresh), sodium bicarbonate, baking powder, sugar, shortening, ammonium bicarbonate and vanilla flavor were procured from a local market (Tanta city, Egypt).

Chemicals and solvents:

All chemicals and solvents used in this study were of analytical grade and were purchased from El- Gomhoria Company for Chemicals and Drugs, Tanta city, Egypt**.**

Methods:

Technological methods:

Preparation of biscuits from wheat flour supplemented with defatted sesame flour:

Biscuit was prepared according to the method illustrated by the Basic dough formula consisted of 100g wheat flour, defatted sesame meal (defatted sesame meal added at level 0, 10,20 and 30% as partial substitution for wheat flour), 30 g sucrose, 20 g shortening, 2g skim milk powder, 1g salt (NaCl), 1.5g sodium bicarbonate,0,3g ammonium bicarbonate and various proportions of water to make required consistency of dough. The biscuits were baked at 170-180°C for 20 min., allowed to cool and subjected to organoleptic, physical, and chemical evaluations.

Evaluation of rheological properties:

Water holding capacity (WHC) and oil holding capacity (OHC):

The residue remained after draining of excess water were weighed whereas **WHC** and **OHC** of the samples were determined as g of water or oil/g sample (**Alkarkhi *et al*., 2010).**

Farinograph tests:

Farinograph parameters i.e., water absorption, arrival time, dough development time, dough stability and degree of softening were determined using farinograph type (g1010500/ Brabender) farinograph West Germany (HZ 50) at Rheological Lab., Department of Bread and Dough, Food Technology Research Institute, Agriculture Research Centre, Giza, Egypt.

Extensograph tests:

Extensograph parameters i.e., the resistance to elasticity, extensibility, proportional number, and energy were determined using an extensograph type 86001 Brabender Extensograph West Germany (HZ 50) at Rheological lab., Department of Bread and Dough, Food Technology Research Institute, Agriculture Research Centre, Giza, Egypt.

Organoleptic evaluation of the obtained products:

Organoleptic assessment of overall acceptability was done using a taste panel consisting of 15 untrained members. All types of samples were served in duplicates in a plate with random arrangement. During the panel test, rinse the panelist's mouth by water to remove any traces of residual food. The sensory attribute included color, order, surface feel, taste, mouth feel, texture and over acceptability were evaluated using a 10 – point hedonic scale with 1 representing the least score (dislike extremely) and 10, the highest score (like extremely) as described by **Iwe (2010).**

Physical properties of the studied products:

Physical properties included measurements of weight (gm, thickens(cm) diameter (cm), spread ratio (D/T), volume (cm^3), relative volume (cm^3/gm) and relative weight(gm/$cm^{3)}$ were determined according to the method of **A.A.C.C. (2002).**

Analytical methods:

Chemical composition:

Moisture, crude protein, crude fat, ash contents and minerals (Fe, Ca, Mg, P and K) of the prepared formula were determined according to the method described in **A.O.A.C. (2016).** Available carbohydrates were calculated by difference.

Polyphenols content:

Extractable polyphenols content (TPC) of defatted sesame meal were spectrophotometrically determined by Folin Ciocalteu's reagent assay using Gallic acid as a standard according to **Vuong *et al.* (2015)**. The absorbance was determined at 750 nm using spectrophotometer (Unicum UV 300). The total polyphenols in the samples were expressed as mg Gallic acid Equivalents (mg GAE/100G dry weight), using a calibration curve.

Total flavonoids content:

Total Flavonoids (TFC)of defatted sesame meal were determined spectrophotometrically by the aluminum chloride method using quercetin as standard (**Vuong *et al.*, 2015)**. The absorbance was measured against blank at 510 nm by using spectrophotometer. Total flavonoids in samples were expressed as mg Quercetin Equivalents (QE/100g dry weight).

Antioxidant activities %:

DPPH radical scavenging activity:

DPPH radical scavenging activity was measured as outlined by **chang *et al*. (2019).**

Statistical analysis:

All data are the means of 3 replicates. Normality of the data was tested with the Kolmogorov-Smirnov test. Data represented as (Mean ± SD). One-way analysis of variance (ANOVA) was used to test the Null hypothesis that all means of groups are equal. If there was a significant difference between means, each treatment was compared with the control suing Dunnett multiple comparisons, Tukey post hoc comparisons among different groups were performed. For all statistical tests P values < 0.05 was statistically significant. Data and statistical analysis were performed using Excel 365 (Microsoft Corporation, USA), and Minitab version 19).

RESULTS AND DISCUSSION

Chemical composition of biscuit samples:

Chemical composition of biscuit made from wheat flour (72%.ext) which partially substituted with 10, 20 and 30% of defatted sesame flour is presented in **Table (1)**. These results indicated that as the partially substituting levels of defatted sesame flour increased, moisture and carbohydrates contents were decreased as compared to the control. The moisture contents were 9.20,9.0 and 8.80% for 10, 20 and 30% of defatted sesame flour substituting levels. Carbohydrates contents were 64.16, 57.57 and 49.75%. for 10, 20 and 30% substituting levels of defatted sesame flour, while the control was 80.52%. However, protein, fat, fiber, and ash contents were increased with increasing the substitution levels of defatted sesame flour. The protein content of the defatted sesame flour biscuit at 30% incorporation level was nearly four times higher than the control biscuit. This observation was linked to higher protein content of defatted sesame flour (33.90%) as compared to wheat flour (10.14 %), (**Table 1**). Similar results for increasing protein, ether extract, fiber and ash and decreasing moisture and available carbohydrates were obtained by **Prakash *et al.* (2018)** who produced biscuits from white and black sesame.

Table (1): Chemical composition of biscuits made from wheat flour (WF) partially substituted with different levels of defatted sesame flour (DSF) (On dry basis).

Biscuit samples	Components (%)					
	Moisture	**Protein**	**Fat**	**Fiber**	**Ash**	**Available carbohydrates**
100% Wheat Flour	10.09	8.70	7.88	1.60	1.30	80.52
90% WF+ 10%DSF	9.20	19.15	13.50	1.45	1.74	64.16
80% WF+ 20%DSF	9.00	24.01	14.01	2.40	2.01	57.57
70% WF+ 30%DSF	8.80	28.75	16.70	2.50	2.30	49.75

Minerals content of biscuit:

Minerals content of biscuit made from wheat flour (72% ext.) which partially substituted with 10, 20 and 30% of defatted sesame flour are presented in **Table (2).** It could be noticed that the mineral contents of biscuit made from wheat flour (72% ext.) partially substituted with different levels of defatted sesame flour increased in all samples as compared with the control (100% wheat flour). The highest biscuit mineral contents were observed for biscuit sample contents of 70%wheat flour + 30% defatted sesame flour which were 29.9 Ca, 17.9 P, 69.4 Fe, 6.862 k and 394.0 Mg mg/g, respectively, while the mineral contents for control biscuit were 19.8 Ca, 16.6 P, 36.2 Fe, 463.2 K and 184.0 Mg mg/g, respectively. Similarly, in this study, partial replacement of wheat flour (72% ext.) with defatted sesame flour considerably improved minerals content of biscuit. These results agree with **U.S.D.A (2009)** and **Karnika *et al*. (2018).** Similar observations were found by **Singh and Raghuvanshi (2012)** in biscuits amended with composite flour of finger-millet and sorghum and in biscuits fortified with malted and sprouted ingredients **(Agrahar- Murugkar *et al*., 2015). Filipcev *et al.* (2011)** reported that partial replacement of wheat flour with buckwheat flour substantially improved minerals content. **Vitali *et al*. (2009)** found that Ca, Mg and Fe content significantly increased with the addition of composite flours. Also, similar results were obtained by **Prakash *et al.* (2018)**; they showed that partial replacement of WF with DFSF considerably improved the minerals content.

Table (2): Minerals content of biscuit made from wheat flour (WF) partially substituted with different levels of defatted sesame flour (DSF)(on dry basis).

Biscuit samples	Minerals (mg/100g)				
	Ca	P	Fe	K	Mg
100% Wheat flour (control)	19.8	16.6	36.2	463.2	184.0
90% WF + 10%DSF	20.1	16.8	39.2	513.3	235.1
80% WF + 20%DSF	24.4	17.2	48.5	594.0	305.1
70% WF + 30%DSF	29.9	17.1	69.4	686.2	394.0

<u>Phytochemical constituents of biscuit samples</u>:

Total phenolic, total flavonoid contents and antioxidant activity of biscuit control and biscuit substituted with different levels of defatted sesame flour are given in **Table (3)**. It could be concluded that, total phenolic content (**TPC)** of substituted samples 20 and 30% was higher than the control sample. It was reported that the control sample had 292.061 mg/100g and biscuit sample had 397.7, 523.961 mg/100g for 20 and 30% substitution, respectively. The same observation was reported in total antioxidant activity (75.469and 91.149 % for 20 and 30% substitution of defatted sesame flour. Total antioxidant activity of control sample showed the lowest value (64.557 %). Also, the control sample showed the lowest **TFC (**Total flavonoid content**) (**128.073 mg/100g). Using 30% of **DSF** (Defatted sesame flour) was the best substitution in TFC 194.850%).

Table (3): Polyphenol's, flavonoid contents and antioxidant activities % of biscuit substituted with different levels of defatted sesame flour.

Biscuit samples	**Total phenolic** (**TPC**) **(mg/100g)**	**Total flavonoid contents (TFC) (mg/100g)**	**Total Antioxidant activity %**
Control biscuit (100% Wheat flour)	292.061	128.073	64.557
Biscuit 20 %(DSF)	397.760	185.176	75. 469
Biscuit 30%(DSF)	523.961	194.850	91.149

Water holding capacity (WHC) and oil holding capacity (OHC) and biscuit samples:

Water holding capacity (**WHC**) or oil holding capacity (**OHC**) is defined as the absorbed amount of water or fat per gram of flour. Data presented in **Table (4)** showed WHC and OHC of biscuit **samples**.

It could be noticed that the control sample had higher WHC value than all other samples. Also, by increasing the substitution of DSF the WHC slightly decreased. The same effect was observed in OHC, it slightly decreased in all substitution samples, while the control one showed the highest value.

One of the factors affecting WHC and OHC values is protein content of foodstuffs **(Butt and Batool, 2010).** Protein has both hydrophilic and hydrophobic properties to interact with water and oil in foods. WHC indicates the hydrophilic capacity of the protein, while the OHC can indicate the hydrophobic capacity of the protein. WHC and OHC were used to indicate protein ability in the food material to prevent fluid loss from a product during food storage or processing **(Adejuyitan *et al.*, 2009).**

The **OHC** of the soybean and mung bean flour was significantly different ($p \leq 0.05$). The ability of flour to absorb and retain water or oil can improve texture and mouth feel, flavor enhancer and reduce moisture and fat loss of food products like comminuted meats, extenders or analogs and baked dough **(Kisambira *et al.*,2015** and **Adebowale *et al*, 2005).**

The **WHC** and **OHC** of biscuits ranged from 0.405 to 0.408 ../... and from 0.404 to 0.408 ../.., respectively. It could be noticed that there were not any differences between control and all other samples in WHC and OHC in biscuit samples.

Table (4): Water holding capacity (WHC) and oil holding capacity (OHC) of biscuits substituted with different levels of defatted sesame flour.

Biscuit samples	WHC	OHC
Control (100% Wheat flour)	0.408	0.408
10% (DSF)	0.406	0.405
20% (DSF)	0.405	0.405
30% (DSF)	0.405	0.404

Organoleptic evaluation of the obtained products biscuit samples:

The organoleptic characteristics of biscuits made from wheat flour substituted with different levels of DSF such as color, surface feel, taste, odor, texture, and mouth feel are illustrated in **Table (5).)**

From the obtained data there were no significant differences in all sensory properties of biscuit except taste score between the control and those blends which contained DSF. The color of biscuits becomes darker as compared with the control. Furthermore, biscuits containing 20% DSF showed maximum sensory scores compared to the other samples and non-significantly difference with control biscuit. However, 30% substitution, the product becomes less acceptable to the consumer. The illustrated results are similar with the results obtained by **Moraes *et al*. (2010)** who found that acceptance of flaxseed, as a dietary ingredient of functional food in cakes, revealed consumer acceptance up to 30% supplementation level. **Eisa** (**2006**) reported that the texture is an important factor of comparing the biscuit as it greatly affects consumer acceptance of the product. **Masoodi and Bashir (2012)** found that the color of the fortified biscuits attained more dark color as the flaxseed and sesame supplementation was increased. However, the texture was slightly decreased with supplementation but described no undesirable change. The overall quality of the biscuits was significantly reduced by addition of sesame cake flour compared with control. This may be due to the concentrated sesame flavor, dark brownish color, nonacceptable taste, rough surface, gritty mouth feels and, less crisp making them to score low in sensory evaluation **Ayana,2015).** However, sesame seeds can be used to improve the nutritive value of bakery products as well as for improving sensory properties **(Anilakumar *et al.*,2010).**

Table (5) Organoleptic evaluation of biscuit substituted with different levels of defatted sesame flour.

Tasted characteristics	**Control** (100% Wheat flour)	**Biscuit substituted with different levels of defatted sesame flour**		
		10%%DSF	**20% DSF**	**30%DSF**
Color	9.08 ± 0.67	8.42 ± 0.9 n.s.	8.33 ± 1.16 n.s.	8.33 ± 0.99 n.s.
Odor	8.50 ± 0.91	8.67 ± 1.07 n.s.	8.50 ± 0.91n.s.	8.25 ± 1.06 n.s.
Surface feel	9.08 ± 0.79	8.58 ± 1.0 n.s.	8.67 ± 0.99 n.s.	8.58 ± 1.24 n.s.

Taste	9.00 ± 0.85	8.50 ± 1.09 n.s.	8.42 ± 1.08 n.s.	8.00 ± 0.95 n.s.
Mouth feel	8.83 ± 0.94	8.83 ± 1.03 n.s.	8.67 ± 1.07 n.s.	8.50 ± 1.0 n.s.
Texture	8.92 ± 0.90	8.75 ± 1.22 n.s.	8.75 ± 0.87 n.s.	8.58 ± 0.79 n.s.
Total score	53.42 ± 1.98	51.42 ± 3.63n.s.	51.50 ± 4.78n.s.	50.42 ± 5.1n.s.

The values represented mean ± SD. Dunnett multiple comparisons with a control; n.s; P value >0.05 was considered not statistically significant.

Physical properties of biscuit samples:

Biscuit **samples** were subjected to physical measurements including weight, thickness, diameter, spread ratio, volume, relative volume, and relative weight. Measurements of substituted flour biscuit at different levels are shown in **Table (6)**.

The results indicated that thickness of biscuit was slightly increased with increasing substitution percentage of DSF compared with control biscuit. The results agree with work done by **Hussain *et al.* (2006)** who found that thickness of flaxseed cookies showed gradually increase as the level of flaxseed flour substitution. Moreover, the results of spread ratio of biscuit revealed a reduction in spread ratio. These results are in line with the findings of **Ganorkar and Jain (2014)** who found that the reduction in spread ratio might be due to increase in dietary fiber and protein.

From the obtained results, it is a significant difference between different samples regarding volume, relative volume, and relative weight. However other physical properties showed no significant difference in comparison with the control sample. The changes in baking properties may be due to the changes in the quality and quantity of protein with the added ingredients and attributed to gas retention of dough during baking process **(Sai and Ras 1997).** So, according to the obtained results of above analysis of sensory and physical properties of different biscuit samples, it was decided to select sample with 20% defatted sesame flour and control due to their high acceptability and good physical properties to continue different analysis and evaluation.

Table (6): Physical characteristics of biscuit partially substituted with different levels of defatted sesame flour.

Physical characteristics of biscuit samples	Control	Biscuit substituted with different levels of defatted sesame flour		
		10% DSF	20% DSF	30% DSF
Weight (gm)	13.19 ± 0.53	12.48 ± 0.25 [n.s.]	13.01 ± 0.34 [n.s.]	13.13 ± 0.37 [n.s.]
Thickness (T) (cm	1.49 ± 0.07	1.40 ± 0.03 [n.s.]	1.45 ± 0.04 [n.s.]	1.46 ± 0.08 [n.s.]
Diameter (D) (cm)	4.00 ± 0.0	4.00 ± 0.0 [n.s.]	4.00 ± 0.0 [n.s.]	4.0 ± 0.0 [n.s.]
Spread ratio (D/T)	2.97 ± 0.11	2.77 ± 0.1 [n.s.]	2.76 ± 0.1 [n.s.]	2.73 ± 0.11 [n.s.]
Volume (cm^3)	17.87 ± 1.88[a]	12.25 ± 1.25[b**]	12.25 ± 1.25[b**]	13.37 ± 1.38[b*]
Relative volume (cm^3/gm)	1.37 ± 0.19[a]	0.97 ± 0.08[b*]	0.94 ± 0.12[b**]	1.00 ± 0.08[b*]
Relative weight (gm/cm^3)	0.73 ± 0.11[b]	1.02 ± 0.09[a*]	1.06 ± 0.13[a*]	0.99 ± 0.08[a*]

The values represented mean ± SD. The means that do not share the same letter are significantly different (p< 0.05, Tukey's Tukey pairwise comparisons test).

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