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Production of High Nutrition Cake from Wheat Flour and replaced by Black Seed Meal or Coconut Meal

Atef A. Abou-Zaid, Naglaa A. Shedeed, A. S. Nadir, Mostafa T. Ramadan and Hesham A. Eissa

Food Technology Department, Food Industries and Nutrition Research Institute, National Research Centre, 12622, Egypt.

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ABSTRACT

In this study, food production waste like black seed meal (BSM) and coconut meal powder (CM) were used to produce highly nutritive cake. Proximate analysis of raw material of (BSM) and (CM) were carried out. (BSM) cakes were prepared by substituting different percentages of (10, 20, and 30%) and (15, 30, and 45%) CM. Chemical composition, physical properties, sensory evaluation of the prepared cakes, was determined. Results were showed that 30% BSM and 45% CM cakes were significantly higher in contents of protein (17.5% and 18.1%), fat (14% and 14.3%), fiber (4.6% and 5.3%) and ash (2.77% and 3.2%) respectively, whereas 30% BSM or 45% CM cakes were lower in carbohydrate content (61.13% and 59.2%) respectively, and had a lower calorific value than the control sample. Results indicated that as the concentration of BSM or CM in the blend increased, the cakes color became significantly darker than control ($P \leq 0.05$). Cakes containing 20% BSM and 30% CM as highly acceptable in relation to their overall acceptability scores and were closest to the control. Results it can be concluded that BSM and CM can be used to produce cakes with good nutritional and physical characteristics with substitution percentages up to 20% and 30%, respectively.

Keywords: Black seed meal, coconut meal, cake, Bakery products, Sensory properties, fiber, high protein cake, high nutrition products.

1. Introduction

According to reports, the food business produces a lot of byproducts, which are trash that seriously pollutes the environment if they are not employed in the manufacturing of feed Simić *et al.,* (2021). In addition to resulting in a significant loss of valuable materials, huge waste volumes can have negative ecological and economic effects.

Food by-products are a growing trend in the food industry because they contain high-nutritive components (fiber, protein, antioxidants, and minerals) that can increase the nutritional value of food products if incorporated or used for fortification, thereby reducing overall waste Vishwakarma *et al.,* (2022). Many studies have examined the impact of food industry by-products on the nutritional characteristics of various food products in recent years Trigo *et al.,* (2022).

Conversely, coconuts have a higher content of dietary fiber and other nutrients (Trinadad *et al*., 2006); they have no gluten and a low digestible carbohydrate content (Ramaswamy *et al*., 2014). Nutritious benefits from the dietary fiber in coconuts include the prevention of chronic illnesses like cancer, heart disease, and diabetes mellitus; they can also help reduce body weight (Ramaswamy, 2014).

Coconut lowers blood sugar levels. Foods with a low glycemic index, especially those with rich dietary fiber, have been shown to improve blood glucose and lipid concentrations in people with diabetes mellitus and to reduce postprandial blood glucose and insulin responses Trinadad *et al*.,

Corresponding Author: Atef A. Abou-Zaid, Food Technology Department, Food Industries and Nutrition Research Institute, National Research Centre, 12622, Egypt.

(2006). Additionally, a variety of delectable pies, cookies, cakes, breads, snacks, and sweets can be made with coconut flour Ramaswamy *et al*., (2014).

Additionally, according to Trinadad *et al*., (2006), wheat flour contains less dietary fiber. will increase the cake's nutritional worth.

Conversely, black seed yielded comparable outcomes; so, it is utilized as a carminative, sudorific, digestive, diuretic, emmenagogue, guaiacol, antifebrile, galactagogue, and cathartic in addition to painkilling. (Razavi and Hosseinzadeh, 2014). The active ingredients found in Nigella sativa (black seed) thymoquinome, thymoquinone, and nogelleone have been demonstrated to have pharmacological, antibacterial, and antitoxic properties by bolstering the body's defenses against infectious disorders (Forouzanfar *et al*., 2014).

The seeds of Nigella sativa, additionally, it was mentioned that the defatted black seed meal has potential for development as a value-added product and as a rich source of fiber and proteins. A valuable byproduct of pressing black seeds, nigella seed cake finds application in numerous industries. The significance of the black seed residue is increased by its high protein and fiber content.

Black seed meal (BSM) is a byproduct of the cold pressing technique used in the oil extraction business to process black seeds. According to Ali *et al*., (2012), it has an 8.1% water content, 23.3% crude protein, and 9.6% ash. Alkaloids, tannins, saponins, vitamin A and C, thiamine, niacin, pyridoxine, and folate, as well as minerals including iron, calcium, potassium, magnesium, zinc, and copper (1.79%–3.44%), are seen. In Salama (2010). Defatted black seed meal (BSM) has minerals such as magnesium, iron, copper, calcium, and potassium along with some residual oils rich in bioactive components even after the oils from the seeds were extracted (Cheikh-Rouhou *et al*., 2007).

Al-Okbi *et al*., (2015) state that isoleucine and methionine are the secondary amino acids found in black seed meal, whereas arginine, histidine, and leucine are the primary amino acids.

The aim of this study was to ascertain the impact of replacing a portion of wheat flour with either coconut meal or black seed meal when making cakes in order to enhance their nutritional content, Farinograph qualities, Physical properties and sensory assessment.

2. Materials and methods

2.1. Materials:

Black seed meal (BSM) and coconut meal powder (CM) were collected from Albasel Company for oil extraction in Abou Horayrah country, Elfarafrah oasis, Marsa Mattroh Governorate, Egypt. Whereas, all BSM and CM were oil extracted from Abasel company. Wheat flour (WF-72%) was obtained from the North Cairo Flour Mills Company, Egypt. Other materials like butter, sugar, baking powder, salt (sodium chloride), whole milk and vanilla used for cake making were purchased from the Dokki local market, Egypt.

2.2. Methods:

2.2.1. Black seed meal (BSM) and coconut meal (CM) powder preparation:

BSM and CM powder were milled to a fine powder using a local milling machine (coffee grinder-Moulinex, France) after that passed from sifter mesh 50 and kept in plastic pages in refrigerator.

2.2.2. Black seed meal (BSM) or Coconut meal (CM) preparation:

BSM was well blended with wheat flour at different levels (10, 20 and 30%) and CM at different levels (15, 30 and 45%) to produce individual mixtures. All samples were stored in airtight containers and kept at 3-5ºC until use.

2.2.3. Gross chemical composition:

Gross chemical composition of raw materials and cakes made by WF, BSM, and CM samples has been analyzed for the following constituents: moisture, protein, fat, crude fiber and ash according to A.O.A.C. methods AOAC (2010). The percentage of crude protein has been calculated by multiplying the total nitrogen content by the conversion factor (N) × 5.7). The gross chemical composition analyses have been measured as a percentage and done in triplicate. Carbohydrates were calculated by the difference as follows:

Carbohydrates (%) = 100 - [moisture% + ash% + proteins% + fat% + crude fiber%].

2.2.4. Farinograph Properties:

Actually, 10%, 20%, and 30% amounts of the BSM or 15%, 30%, and 45% amounts of the CM were replaced with the same amounts of wheat flour. The effect of the different flour replacement levels on farinograph properties determined by farinograph apparatus (Model Type No: 81010 using 31, 50 and 63 rpm, ©Brabender® OHG, Duisburg, 1979, Germany) according to the standard methods of AACC (2000). The measured parameters were water absorption, Arrival time (min), dough development time (min), dough stability and weakening value (BU).

2.2.5. Cake Making:

Cake making was carried out at automatic commercial baking line according to AACC (2000). The cake ingredients were100g flour, 104 g sugar, 40 g shortening, 56 g egg albumen, 11.5 g skim milk, 5.8 g baking powder, 0.5 g vanillia, 1g emulsifier agent (Glecrid Mono Stearat) 64ml water and 5g of cacao as the color mask in BSM samples. The cakes were manufactured as follows:

The sugar and shortening were mixed together and the egg albumen was added and the mixture was whipping. The other components were added and the whipping process was completed and after that, the paste was put in bowel and baking at 170-175°C for 35-40min. After two hours the organoleptic evaluation test was carried out. The cakes were allowed to cool at room temperature for 2h before being packaged in polyethylene bags and stored at 3-4°C temperature for further analysis.

2.2.6. Calorific value:

The total calories of the samples were calculated according to James, (2013) as follows:

Total calories (Kcal/100 g) = (Fat × 9 Kcal) + (Protein × 4 Kcal) + (Carbohydrate × 4 Kcal)

2.2.7. Physical Characteristics of Cakes:

Weight, volume and specific volume of cakes were measured according to the methods described by Bennion and Banford (1983). A graduated scale (in centimeters) was used to measure the height of cakes. For measuring cakes volume, a glass box designed to hold the article was used. The box was placed on the tray and filled with rap seeds delivered from its container in a steady stream to a fixed height until the box was filled and the seeds over flowed into the tray. The surface of the seeds was then leveled by removing the surplus by straight edged scraper. The seeds in the box which representing the volume of the box was transferred to an empty container and the cake was placed in the measuring box. The seeds were filled into the box containing, the cake until the box over flowed. Leveling of surface of the seeds and the excess seeds in the container were measured. The volume of the cake was the volume of rape seed rest. The specific volume of the cake was calculated by using the following equation:

$$\text{Specific cake volume} = \frac{\text{Cake volume}}{\text{Cake weight}} \ [\text{g/ML}]$$

2.2.8. Sensory Characteristics of Cakes:

The cakes were allowed to cool on racks for about 1h before evaluation. Cakes were organoleptically estimated for the tested attributes by 10 well trained panelists according to Bennion and Banford (1983). Sensory characteristics (highest, Crust color, odor, taste, crumb grain, texture and general appearance) were evaluated by ten staff members of the department of Food Technology, Food Industries and Nutrition Institute, National Research Centre using a numerical scale point. Whereas, the score value was highest (15), taste (30), crust color (10), odor (10), crumb grain (10), texture (15) and general appearance (10).

2.3. Statistical analyses:

Standard deviation (SD) calculations have been done by using the software Excel 2010. Statistical analysis was conducted with the CoState program using a one-way analysis of variance (ANOVA). The statistical analysis of the obtained results was done with triplicate replications, except for the sensory evaluation data, which had 20 replicates Tudor-Radu *et al*., (2016). Data were represented as means followed by ± (SD).

3. Results and Discussion

3.1. Gross chemical composition of WF, BSM and CM raw materials:

Table (1) reported the general chemical composition of BSM, CM, and wheat flour. Wheat flour (WF) had higher moisture and carbohydrate levels (11.2% and 85.47%) than BSM (8.07% and 51.26%) and CM (4.5% and 53.6%), respectively. Higher protein, fat, ash, and crude fiber levels were found in BSM and CM (29.01%, 10.97%, 5.55%, and 13.03% in BSM, respectively), CM (21.03%, 9.82%, 5.05%, and 10.5%, respectively), and WF (12.8%, 0.8%, 0.52%, and 0.41%, respectively). According to reports, the results of WF coincide with Mahmoud *et al*., (2023) and the results of BSM differ Afoakwah *et al*., (2019) in accordance with Abo-Taleb *et al*., (2022) of CM.

According to Table 1 results, the gross chemical composition of WF, BSM, and CM revealed that the latter two contained more nutrients than the former. Afoakwah *et al*., (2019) and Thilakarathna *et al*., (2018), in that order.

According to Ramaswamy, (2014), composite flours with favorable properties for cake production are produced by CM's high nutrient content, low gluten, and chemical makeup, as well as WF's high carbohydrate content, particularly starch. These findings are consistent with those published in BSM by Thilakarathna *et al*., (2018).

Table 1: Gross chemical composition (%) of WF, BSM and CM Samples.

Sample	WF	BSM	CM
Moisture	11.2	5.42	4.5
Protein	12.8	29.01	21.03
Crude fat	0.8	10.97	9.82
Crude fiber	0.41	13.03	10.5
Ash	0.52	5.55	5.05
Carbohydrate	85.47	41.44	53.6

Where: wheat flour WF, black seed meal BSM and coconut meal CM.

3.2. Gross chemical composition (%) of WF and different levels of CM or BSM cakes samples:

In comparison to the control cake, Table (2) displayed the overall chemical composition of cake samples augmented with varying amounts of BSM or CM. The cake sample containing 15% CM had the highest moisture content of 5.3%, while the cake sample with 10% CM had the lowest moisture level of 5.01%. The range of the protein content was determined to be 12.8% in the control cake and 18.1% in the cake containing 45% CM. The cakes' ash contents ranged from 1.6% in the control cake to 3.2% in the cake that had 45% CM. The fat level of the cake samples did, however, differ somewhat; it ranged from 13.2% for the control cake to 14.2% for the 45% CM cake.

As the substitution proportion of BSM or CM grew, the amount of carbohydrates and calories in the cake steadily fell in a negative manner for all samples. This may be because the raw materials utilized in the combinations had low carbohydrate contents to begin with. These findings concur with those of Mahmoud *et al*., (2023) and Afoakwah1 *et al*., (2019).

Cake samples with 30% BSM or 45% CM had higher levels of protein, fat, fiber, and ash content than the control cake, whereas the same samples had lower levels of carbohydrates. These results are consistent with those of Al-Marazeeq and Angor (2017), who found that adding 30% BSM to cakes boosted their protein, fiber, and ash content significantly ($P \leq 0.05$). Simić *et al*., (2021) and Khalil *et al*., (2021) observed similar trends in bread, while Afoakwah1 *et al*., (2019) reported on about 45% CM in cake.

Table 2: Gross chemical composition (%) of WF and different levels of CM or BSM cakes samples.

Sample	Moisture	Ash	Protein	Crude fat	Crude fiber	Carbohydrates	Cake calories*
Controle	5.1	1.6	12.8	13.2	1.1	71.3	455.2
10% BSM	5.01	2.01	14.2	13.5	2.3	67.99	450.26
20% BSM	5.2	2.39	16.04	13.7	3.5	64.37	444.94
30% BSM	5.2	2.77	17.5	14.0	4.6	61.13	440.52
15% CM	5.3	2.3	14.5	13.7	2.5	67.0	449.3
30% CM	5.4	2.7	16.1	14.1	3.9	63.3	444.5
45% CM	5.2	3.2	18.1	14.3	5.3	59.2	437.9

Where: black seed meal BSM and coconut meal CM.* Cake calories as Kcal/100 g

3.3. Effect of replacement levels of wheat flour (72%) by different levels of CM or BSM on Farinograph properties:

The date in table (3) indicates Effects of adding BSM (at 10, 20, or 30%) or CM (at 15, 30, or 45%) to wheat flour on the characteristics of dough mixing (Farinograph). were demonstrated that when the percentage of BSM or CM added increased, the water absorption increased as well. This is because the blends had more protein and fiber, which had the capacity to bind water (marginal). Sudha and associates (2007). Water absorption significantly changed in response to the addition of BSM to WF, rising from 56% in the control to 59.2% at 30% BSM and 61.1% in 45% CM. This shift was linear.

When rice or wheat bran was added, similar effects on water absorption were noted. According to studies by Rosell *et al*., (2001) and Eissa *et al*., (2007), samples with higher protein, fiber, and sugar contents may account for variations in water absorption. These substances held onto water better and were able to create more water contacts through hydrogen bonding, mostly because of the increased number of hydroxyl groups present in the fiber structure.

Because the fiber needs a little extra time to bind the water, there was a positive correlation between the amount of dough development time (DDT) increase and BSM or CM levels.

Dough stability, which shows how increasing BSM or CM causes the dough strength to diminish in a variety of ways. As a result of BSM or CM increasing the gluten network diluted in patterns containing CM, the final results demonstrated that the weakening of dough was detected with an increase in BSM or CM level. However, in samples containing BSM, this was because the phenolic component in BSM reduced the active sulfur bonds in the gluten protein (Yüksel *et al*., 2023 and Osman *et al*., 2015).

Table 3: Effect of replacement levels of wheat flour (72%) by different levels of CM or BSM on farinograph measurements.

Sample	Water absorption (%)	Arrival time (min)	Developing time (min)	Stability time (min)	Weakening value (BU)
Control	56	1.5	4.5	6	80
15% CM	57	1.7	5.0	10	100
30% CM	58.1	1.9	5.5	8	110
45% CM	59.2	2.0	6.5	5	120
10%BSM	57.5	1.6	5	9	90
20%BSM	59	1.8	6	7	100
30%BSM	61	2.0	6.5	5	120

While (WF) wheat flour, (BSM) black seed meal and (CM) coconut meal

3.4. Physical Properties of the Cake samples produced from WF and different level of BSM or CM:

The physical characteristics of cakes made from BSM or CM blends are displayed in Table (4). The cake sample generated with 100% WF had the lowest volume (189 ml), whereas the ones using

15% or 30% CM had the highest volume (194 ml and 196 ml, respectively). Similar to the results of samples containing BSM, samples with 10% or 20% ratios had volumes of 192 ml and 194 ml, respectively. However, the volume of the control sample was larger than the volumes of the samples with 45% Cm and 30% BSM, which were 140 ml and 144 ml, respectively.

It's because the gluten network weakens when BSM is increased to 20% or CM to 30%, but at higher levels, the gluten network breaks down and loses its ability to hold air in paste. Proteins that form structures and the dough's diminished capacity to enclose air during the proving process may have a volume-depressing effect on the baked goods made from composite flours. Abou-Zaid *et al*., (2011) and Akobundu *et al*., (1988).

This result suggests that the increasing ratio in blends created smaller cake volume, as measured by the cake volume observed by BSM addition to 30% level in blends or CM addition to 45% over those level. Ade-Omowaye *et al*., (2008) and Afoakwah *et al*., (2019) observed similar findings in their study on an increase in the percentage of tiger nut in wheat-tiger nut composite flour. Similar to this, a study by Aluko and Olugbemi (1989) found that the bake items made using composite flours had smaller volumes than those made with wheat flour. Additionally, the precise volume of the cake in comparison to those made from BSM or CM blends. According to a study, gluten-free flour weakens the gluten network created during the mixing and kneading of the dough Taha (2000). At low levels, this may lead to a specific increase, but at higher levels, the volume of the cake will decrease relative to the control Tanya (2016).

Table 4. Physical properties of the cakes samples produced from WF and different level of BSM or CM.

Sample	Volume (cm^3)	Weight (g)	Specific volume (cm^3)/(g)
Control	189	90	2.1
15% CM	194	90.5	2.14
30% CM	196	90.1	2.18
45% CM	144	90	1.6
10% BSM	192	90	2.13
20% BSM	194	90.2	2.15
30% BSM	140	90.1	1.55

While (WF) wheat flour, (BSM) black seed meal and (CM) coconut meal

3.5. Sensory evaluation of the cakes samples produced from WF and different level of BSM or CM:

Table (5) displays the average ratings for the different cake samples' sensory characteristics. The judges gave the example coconut cake the highest color score when it came to mixes including 15% or 30% CM. mixes containing 10% or 20% BSM also received the same scores, however blends containing 30% BSM or 45% CM had lower scores across the board.

The coconut wheat cake received a higher texture rating, though. Therefore, the dietary fiber in coconut wheat cake might have enhanced the cake's ability to absorb water, giving it a softer texture, mouthfeel, and staling retard. This could also be a factor in the popularity of coconut wheat cake as the best-tasting cake product. Furthermore, the unique flavor of coconut wheat cake can be ascribed to the unique vitamin and fiber profile of CM mixes cakes.

Cakes with BSM 30% and CM 45% showed a decrease in look and color values. This resulted from the BSM and CM cakes, as well as the BSM cakes' darker hue at higher levels. This can be explained by the fact that the panelists were able to visually separate the samples solely on the basis of color and the degree of imperfections visible on the cake's crumb and surface; however, the appearance score was noted when 5% cacao was added to blends containing BSM.

Table (5) indicates that there was a gradual decrease in the amount of carbs and a rise in fiber in the cake samples, which resulted in a darker color of the cakes and a fall in their surface and crumb appearance values. This could be the cause of the decline in appearance values. Appearance, moisture content, and total carbs are positively correlated. On the other hand, ash, fat, and crude fiber have a negative correlation with attractiveness (Man *et al*., 2021).

When evaluating consumers' reception of products, texture is crucial. Most of the time, a consumer's taste for a product is largely unconscious and is influenced by its texture. The intricate texture changes that occur while eating (mouth behavior) might affect whether a food is accepted or rejected. Gyura *et al*., (2005). The texture of the cake remained unaffected by the substitution levels. Because of CM's distinct nutty flavor, CM cakes scored higher on taste tests than BSM cakes. The control sample received the highest ratings across the board from the sensory panelists.

This blend with 30% CM came in just after it. The control sample and the 30% CM sample had the highest overall acceptability scores, at 95% and 98%, respectively. The acceptability scores decreased after this degree of substitution. The overall acceptability of 10% BSM cake and 15 and 30% CM cakes did not differ significantly. The cake made with 30% BSM received the lowest rating for acceptability overall. According to Man *et al*., (2021), there is a negative correlation between the cake's flavor and aroma and its protein, ash, fat, and crude fiber content, and a positive correlation with its total carbohydrate content.

Table 5: Statistical analysis of sensory evaluation (mean values) of cakes as affected by WF and different levels of BSM or CM.

Cake sample	Highest	Taste	Crust color	Odor	Crumb grain	Texture	General appearance
WF(control)	$14.5^{a}\pm1.02$*	$29.5^{b}\pm1.14$	$9.8^{a}\pm0.67$	$9.6^{ab}\pm0.71$	$9.9^{a}\pm0.66$	$14.6^{a}\pm1.10$	$9.9^{a}\pm0.67$
BSM 10%	$14.3^{ab}\pm0.98$	$28.5^{c}\pm1.13$	$9.2^{b}\pm0.66$	$9.0^{b}\pm0.68$	$9.5^{b}\pm0.64$	$14.2^{b}\pm1.11$	$9.3^{b}\pm0.65$
BSM 20%	$14.0^{b}\pm0.97$	$26.1^{d}\pm1.11$	$8.2^{c}\pm0.58$	$8.0^{c}\pm0.59$	$9.0^{ab}\pm0.63$	$13.0^{c}\pm0.97$	$8.8^{c}\pm0.61$
BSM 30%	$13.8^{c}\pm0.94$	$22.8^{e}\pm1.08$	$7.7^{d}\pm0.51$	$6.8^{d}\pm0.46$	$8.1^{d}\pm0.58$	$11.3^{ab}\pm0.92$	$7.5^{d}\pm0.55$
CM 15%	$14.4^{a}\pm1.01$	$29.9^{a}\pm1.18$	$9.6^{a}\pm0.61$	$9.8^{a}\pm0.75$	$9.6^{ab}\pm0.67$	$14.3^{ab}\pm1.13$	$9.8^{a}\pm0.65$
CM 30%	$14.5^{a}\pm1.04$	$29.8^{a}\pm1.15$	$9.4^{b}\pm0.65$	$9.6^{ab}\pm0.69$	$9.2^{bc}\pm0.63$	$12.8^{c}\pm0.91$	$9.2^{b}\pm0.59$
CM 45%	$14.2^{b}\pm0.99$	$29.7^{ab}\pm1.11$	$9.1^{bc}\pm0.59$	$9.7^{a}\pm0.71$	$9.0^{c}\pm0.60$	$11.4^{d}\pm0.87$	$6.4^{e}\pm0.52$
L.S.D.*	0.397	0.405	0.399	0.711	0.401	0.398	0.502

While (WF) wheat flour, (BSM) black seed meal and (CM) coconut meal
*±Standard Deviation (SD)/SQR^{2} (n), where n = 3 , L.S.D. = Least Significant Difference

4. Conclusion

The goal of the current study is to determine whether BSM or CM can improve the nutritional content and physical attributes of cakes. The findings showed that while carbohydrate was reduced by increasing substitution, protein, fat, ash, and fiber contents were much higher in BSM and CM. Because of this, the BSM or CM cakes had higher nutritious contents than the control cake. The cakes' appearance was adversely affected and their color became deeper due to the higher concentration of BSM or CM in the blends. On the other hand, adding 5% cacao powder to blends containing BSM improved the cakes' physical characteristics.

The substitution of BSM or CM in the cake formulation suggested by this study is an example of how research and trends in bakery products can work well together. Therefore, it is strongly advised that the WF cake composition include 20% BSM and 30% CM. Therefore, with reasonable acceptability, these cakes provide consumers with healthier and more nutritious options. Additional research on the effects of storage conditions and duration on the qualitative attributes of BSM or CM enriched cakes or a related baking product may prove advantageous. Therefore, adding BSM or CM could result in composite flours that have favorable properties for making cakes.

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