Chemical, Rheological and Quality Characteristics of Gluten Free Biscuits Made from Sorghum flour and Oyster Mushroom (*Pleurotus plumonarius*) Powder blends

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Abstract:

Biscuits containing levels of Mushroom Powder (MP) were produced by replacement of sorghum Flour (SF) with 0, 10, 20 and 30% (MP). Effect of (MP) supplementation on the biscuit properties, proximate analysis, rheological properties and sensory qualities were evaluated. Water absorption, dough development time (DDT) and dough weakening increased were significant increased at (p≤0.05) in positive relation with MP level increased in the dough, but mixing tolerance index (MTI) and dough stability decreased relatively marginal by mushroom powder increasing. Baking properties, color and sensory evaluation tests showed that 30% of sorghum flour could be replaced with mushroom powder still providing good quality of biscuits. Biscuit diameter, specific volume, crumb texture and crispness were decreased by MP from 0-30% increasing. Supplementation of SF with MP from 0-30% increased the crude protein content from 8.9-14.4%, and crude fiber 0.73-1.33% in produced biscuits. Sensory evaluation based on appearance, crust color, crumb texture, crumb color, taste, flavor and overall acceptability showed there were no significant (p≤0.05) difference between 10% MP fortified biscuit and 100% (SF) biscuit (control) in all evaluated. Equally, 20% MP fortified biscuits did not differ significantly in texture, color, taste, flavor, it compared favorably well with control in these attributes. Biscuit with 30% MP replacement though had significantly (p≤0.05) lower compared to control, also it was acceptable to the panelist. Mushroom powder therefore could be added to sorghum flour up to 10% without any observed detrimental effect on biscuit sensory properties. This could be used to improve the nutritional quality of biscuit especially in developing countries were malnutrition common, and produce biscuits suitable for autism and celiac.

Key words: Mushroom powder, biscuit, fortification, quality, acceptability

Introduction

Biscuit is one of widely consumed food product. It is a cereal product that is naturally low in protein and nutritionally not balanced diet due to it is low in lysine, an essential amino acid **(Agu *et al.*, 2010).** However, **Anyika and Uwaegbute (2005)** reported that there is an increased tendency among children and adults to move away from traditional eating pattern to eating snack foods such as biscuits. Also, **Kansas (2006)** reported that increase in cookies consumption is fastest in cities where they are now considered suitable foods. Since biscuit is important food that is generally accepted, they could be excellent and convenient food item for protein fortification to improve the nutritional of people and in nutritional programs which will enhance reduction in protein malnutrition that is prevalent in developing countries. Fortification of sorghum flour with high protein component to increase the protein and improve the essential amino acids balance of the resultant baked product **(Agu *et al.*, 2010)**.

Mushrooms are edible fungi that contain high quality digestible protein that ranged between (10-40%), carbohydrate (3-21%) and dietary fiber (3-35%) on dry weight basis **(Mallavadhani *et al.*, 2006).** Most species contain all the essential amino acids about the same proportion as in egg **(Quimio *et al.*, 1990)**. Lysine which is deficient in most grain cereals like sorghum is the abundant essential amino acid in Mushroom **(Friedman, 1975)**, so mushroom will complement well with sorghum flour to produce nutritionally balanced high quality biscuit. It is also good source of B-vitamins (thiamin, niacin, riboflavin, biotin, pyridoxine, panthotenic acid) and vitamin C. It also involves significant amount of mineral elements like iron, phosphorus, potassium and calcium **(Friedman, 1975).** Mushrooms are not only sources of nutrients but have also been reported as therapeutic foods, useful in preventing diabetic, cancer and heart diseases **(Bobek and Galbavy, 1999)**. Their cultivation have increased tremendously recently because they are popular, well accepted and used as food, especially for soup preparation as substitute for meat **(Okeke *et al.*, 2003).** Therefore, one of the aims of the present study include the utilization of the oyster mushroom in biscuit enrichment and effect of this supplementation on the physical, nutritional and sensory properties/acceptability of the products.

Total wheat production in Egypt about 50% of the total consumption. The way to overcome this problem must be found cereals used as wheat substitute in bakery products. Biscuits are convenient food products and the most popular bakery items consumed nearly by all levels of society in Egypt. Most of bakery products are used as a source for incorporation of different nutritionally rich ingredients for their diversification **(Gandhi *et al.*, 2001; Hooda and Jood 2005;** and **Sudha *et al.*, 2007).** The enrichment of protein may be achieved through the incorporation of protein–rich non-wheat flours **(Gandhi *et al.*, 2001** and **Sharma and Chauhan, 2002).**

Mushrooms have great potential, due to their high good quality protein (24–35%), whereas mushrooms have better nutritional qualities (higher lysine), (**Petrovska *et al.*, (2002).** Therefore, fortification with mushroom could provide good opportunity to improve the nutritional quality of protein consumed by many people. Also, fortification of sorghum flour with mushroom proteins increases protein quality by improving its amino acid profiles **(Stark *et al.*, 1975** and **Hoover, 1979).**

In typical functioning gastrointestinal tracts, enzymatic activity breaks proteins into peptides, and transforms peptides into amino acids. The intestinal lining then absorbs the amino acids into the blood stream, which carries the amino acids to the rest of the body, providing nutrition. The Opioid-Excess Theory alleges ASD can result from disruptions to this process. According to the theory, some individuals suffer from inadequate production of gluten- and casein-related digestive enzymes, and increased gut permeability. Without adequate levels of digestive enzymes, peptides derived from gluten and casein fail to become amino acids in large numbers. Increased gut permeability then allows the peptides to leak into the blood stream, where they circulate and eventually cross the brain–blood barrier. Symptoms of ASD are theorized to result from peptides' attaching to opioid neuro-receptors **Wakefield *et al.*, 1998** and **Whiteley *et al.*, 1999).** Therefore, the present study was aimed to evaluate the suitability of partial replacement of wheat flour using milled mushroom in biscuit making through the effects of milled mushroom addition at levels 0, 10, 20 and 30% on the rheological properties of dough and on the quality parameters (physical, chemical, protein content, color and sensory characteristics) of biscuits.

Materials And Methods Materials:

Sorghum flour (Sorghum bicolor) from the variety Dabar was obtained from main Crops Department, Field Crops Institute, Agricultural Research Center, Giza, Egypt. Oyster mushroom *(Pleurotus colombinus)* was obtained from the unit of mushroom production, Center of Mushroom Services, Agricultural Research Center, Giza, Egypt.

Preparation of mushroom powder:

The mushroom powder was prepared in the laboratory from fresh mushroom using the method described by **Okeke *et al.,* (2003).** The dried mushroom was milled using a hammer mill (CN;HUB Type: Mill Machine Brand Name: XL) and sieved to pass through a 60 mesh sieve (British Standard Screen). The powder was packaged in a low density polyethylene bag, sealed, stored in the refrigerator (4°C) until required.

Preparation of Blends between Mushroom Flour and Sorghum Flour:

Sorghum flour was well blended and replaced with specified amounts of mushroom powder (MP) to produce mixtures containing 0, 10, 20 and 30%. All samples were stored in airtight containers and kept at 3-4°C until analysis.

Biscuits Making:

Biscuits, control and Blended with MP at levels containing 0, 10, 20, and 30 were prepared according to the procedure described by **AACC (2005)** with slight modifications. The ingredients included Sorghum flour or blends were used as described by **Sudha *et al.,* (2007).** The formula was contained: 100g wheat flour or its tested blends, 57.77 g sugar, 7.1 ml water, 6 ml fresh orange juice, 28.44 g shortening, 0.93 g salt (sodium chloride), 1.11 g sodium bicarbonate and 14.66 g dextrose. All the previous ingredients were mixed for 15 min using a mixer. The dough was then rolled between sheets of wax coated freezer paper to a uniform thickness of 9 mm and was cut using a circular mould to a diameter of 6.5 cm. Biscuits were baked at 205°C (400°F) for 9-10 min in a conventional air-fan electric oven. After baking, the biscuits were cooled to room temperature, packed in polyethylene pouches and sealed until analysis.

Analytical Methods:

Determination of protein and crude fiber

Protein and crude fiber were determined according to the Standard Association of Official Analytical Chemistry methods, **AOAC (2005)**.

Determination of amino acids pattern

Amino acids pattern for mushroom powder protein, sorghum flour protein were determined by using amino acids analyzer (Bekman 7300, Jermany) according to the standard method described in **AACC (2005).** Indispensable amino acid (IAAs) score was calculated in comparison to the reference protein pattern of **FAO/WHO., (1973)** using the following equation: IAA score = mg of the IAA in tested protein × 100/mg of the IAA in the reference protein pattern.

Dough Characteristics

The effect of mushroom powder levels (0, 10, 20 and 30%) on dough rheological properties was determined by Farinograph (Model Type No: 81010, Brabender® OHG, Duisburg, 1979, Germany) according to the standard methods AACC (2005). The measured parameters were water absorption, dough development time, dough stability and mixing tolerance index (MTI).

Physical Characteristics of Biscuits

All parameters were measured by Boclase (HL 474938, STECO, Germany). Physical parameters such as diameter, thickness, spread and specific volume were determined using procedure of AACC (2005). Diameter of biscuits was measured by laying six biscuits edge to edge with the help of a scale rotating those 90° and again measuring the diameter of six biscuits (mm) and then taking average value. Thickness was measured by stacking six biscuits on top of each other and taking average thickness (mm). Weight of biscuits was measured as average of values of four individual biscuits with the help of digital weighing balance. Spread ratio was calculated by dividing the average value of diameter by average value of thickness of biscuits. Protein content of all samples was determined according to the macro Kjeldahl method **(AACC, 2005).**

Color Determinations:

Objective evaluation of biscuits surface color and pan bread crust color was measured. Hunter (a*, b* and L*) parameters were measured with a color difference meter using a spectro-colorimeter (Tristimulus Color Machine) with the CIE lab color scale (Hunter, Lab Scan XE-Reston VA, USA) in the reflection mode. The instrument was standardized (at each time) with a white tile of Hunter Lab Color Standard (LX No.16379): X= 72.26, Y= 81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16) **(Sapers and Douglas, 1987).**

Sensory Characteristics:

The pan bread samples were allowed to cool on racks for about 1h before evaluation. Pan bread loaves were organoleptically evaluated for general appearance, crust color, taste, odor, crumb color, structure by 12 trained panelists of Food Science Department, National Research Center Stuff according to Gujral et al. (2004). Sensory characteristics of biscuits were evaluated according to Zabik and Hoojjat (1984) with some modifications. However, the sensory characteristics of biscuits were determined, using a taste panel, consisting of 12 trained judges. The panelists were asked to evaluate the surface color, taste, odor, shape, texture and structure of the tasted samples.

Statistical analysis:

Experiments were repeated three times and the results were subjected to analysis of variance (ANOVA). The Duncan comparison test was applied when a significant difference ($p<0.05$) between the products was revealed through software (SPSS, Zar 1984) ver 19.

Results And Discussion

The chemical composition of the sorghum flour and mushroom powder were shown in Table 1. Mushroom powder had relatively high content of protein (38.42%), fat content (2.01%) ash content (7.85%) crude fiber (7.95%) and low content of carbohydrate (43.77%) while sorghum flour was observed to have low contents of protein (11.34%), fat content (0.68%) ash content (1.81%) and crude fiber (0.33%).

Table 1: Chemical composition of Sorghum flour, and mushroom powder (Mean±SD % dry basis)

Parameters %	Sorghum flour	Mushroom powder (%)
Moisture	13.32±1.23	8.8±0.69
Crude protein	11.34±1.09	38.42±2.22
Fat	0.68± 0.10	2.01±0.14
Ash	1.81±0.23	7.85±1.06
Crude fiber	0.33±0.01	7.95±2.08
Carbohydrate	85.84±3.11	43.77±4.02

Nutritional quality of mushroom powder protein compared with sorghum flour protein

Data given in Table 2 shows the amino acids composition (g/100g protein) of mushroom powder protein compared with sorghum flour protein. From such data it could be illustrated that the mushroom powder protein composed of all essential amino acids (EAA); isoleucine, leucine, lysine, sulphur containing amino acids (methionine and cystine), aromatic amino acids (phenylalanine and tyrosine), valine and threonine at concentration of 4.70, 7.5, 7.7, 2.1, 7.7, 6.3 and 4.1g/100g protein; respectively. These values were noticed to be higher than the corresponding concentrations in the reference protein pattern, with the exception of (methionine and cystine) which were the limiting EAA amino acid in the mushroom powder protein (**(Okaka, 2005**). Therefore, mushroom powder protein characterizes with good nutritional protein quality. These results are in accordance with those reported by **Okaka (2005).** On the other hand, mushroom powder protein contained the most indispensable amino acids at higher concentrations than those for the corresponding indispensable amino acids in sorghum flour protein (4.3, 13.2, 2.11, 2.7, 9.3, 5.4 and 3.1 g/100g protein; respectively) thereupon, it should be directed towards the utilization of the mushroom powder protein in food products fortification with the IAAs, especially cereal products such as biscuits. These results are nearly in conformity with those noticed by **Agu *et al.*, (2010) and Okafor *et al.,* (2012).**

Table 2: Amino acid composition of mushroom powder (MP), and sorghum flour and reference protein of FAO/WHO

Amino Acids	Mushroom powder (g/100g)	IAA score	Sorghum flour (g/100g)	IAA score	FAO/WHO g/100g protein
Essential					
amino acids	4.7	117.5	4.3	107.5	4.0
(EAA)	7.5	107.1	13.2	188.5	7.0
Isoleucine	7.7	140.0	2.11	38.3	5.5
Leucine	6.3	126.0	5.4	108.0	5.0
Lysine	4.1	102.5	3.1	77.5	4.0
Valine	2.1	61.8	2.7	79.4	3.4
Therionine	7.7	126.2	9.30	152.5	6.1
Meth+Cyst					
Phen+Tyro					
Non-Essential	6.5		9.51		
amino acids	6.5		3.9		
(NEAA)	11.6		7.04		
Alanine	16.6		21.8		
Arginine	4.7		3.12		
Aspartic acid	2.8		2.22		
Glutamic acid	4.9		8.30		
Glycine	4.4		4.80		
Histidine					
Proline	98.1		100.8		
Serine	40.1		40.11		
	58.0		60.69		
Total Amino Acid					
Total EAA					
Total NEAA					

Influence of mushroom powder (MP) addition on dough properties by farinograph

Variation in blending ratios 0, 10, 20 and 30% of MP on dough mixing properties, farinograph, with sorghum flour showed differences in dough mixing properties (Table 3).

Table 3: Farinograph measurement properties of sorghum flour and their blends with MP

Samples	Water absorption %	Arrival time (min.)	Mixing time (min.) (DDT)	Dough stability (min.)	Weakening value (B.U.)
Sorghum flour 100%	56.0a	2.0a	3.0a	2.00a	60a
10 % MP + 90% sorghum flour	58.5b	2.5b	4.0b	5.00b	90b
20 % MP + 80% sorghum flour	61.0c	3.0c	5.0c	6.50c	110c
30 % MP + 70% sorghum flour	63.5d	4.0d	6.5d	9.00d	140d

Where: (MP) = Mushroom powder.

Means in the same column with different letters as superscript are significantly different ($p<0.05$)

Addition of Mushroom powder (MP) mainly increased the water absorption. By increasing the sample level from 10% to 30% the highest increase in water absorption was found with the addition of 30% of Mushroom powder (MP) (63.5%). The significant increased at ($p\leq0.05$) in the water absorption was marginal. Similar effects on water absorption were observed **by Etssa *et al.,* (2007) and Abou-Zaid (2012)** when fiber increased the water absorption increased due to the greater number of hydroxyl groups which exist in the fiber, sugars, higher protein content and structure which retain more water and allow more water interactions through hydrogen bonding. The extent of increase in arrival time or dough development time (DDT) was increased by Mushroom powder increasing to be 6.5 min in 30% mushroom powder addition compared to 3.0 min in control sample. Dough stability which indicates the dough strength, increased to 9 min compared to 2 min in control. Greater effects were observed on the weakening value. It was increased by mushroom powder increasing. It is due to that with all mushroom powder increased, the net work gluten was diluted led to weakening values increasing, as reported by **Abou-Zaid (2012).**

Influence of mushroom powder on physical characteristics of biscuits

Physical characteristics of biscuits, such as thickness, diameter and spread ratio were low affected by the substitution increment of the level of mushroom powder (Table 4).The changes in diameter and thickness reflected the spread ratio which showed significant ($p \leq 0.05$) increased from 6.45 in control samples to 6.89 at 30% levels of MP substitution. The diameter increases as the thickness decreases with the increase of the DMF. According **to Baljeet *et al.*, (2010),** these two parameters are still evolving in reverse. The spread ratio is the ratio between the diameter and the thickness and this parameter is important to assess the quality of the biscuits (**Bose and Shams Ul-Din, 2010**). Biscuits with high spread ratio values are better **(Eissa et al., 2007) and (Koffi *et al.*, 2013)**. The quality of biscuits is also evaluated by its specific volume which is a technological parameter that can adequately inform on the textural properties of the dry biscuits **(Igrejas *et al.*, 2002; Manohar *et al.*, 2002; Pedersen *et al.*, 2004 Fustier *et al.*, 2007).**

Table 4: Physical characteristics of the tested biscuits samples

Samples	Thickness. (mm)	Diameter. (mm)	Spread ratio	Weight (g)	Volume (cm3)	Density (g/cm^3)
Sorghum flour 100%	10.a	64.5 a	6.45 a	90.50 a	145 a	0.620 a
10 % MP + 90% sorghum flour	10.0 a	65.0 b	6.50 a	89.82 a	146 b	0.615 a
20 % MP + 80% sorghum flour	9.70 ab	65.0b	6.70 a	89.70 b	146b	0.614 a
30 % MP + 70% sorghum flour	9.50 b	65.5 c	6.89b	89.24 bc	147 c	0.607 a

Where: (MP) = Mushroom powder.

Means in the same column with different letters as superscript are significantly different ($p<0.05$)

Influence of MP on protein content of biscuits

Tables (5) show that protein content increased with increasing mushroom powder in the biscuit blends. Control biscuits had 8.9% protein and 0.73% crude fiber contents. Biscuits were supplemented with mushroom powder at 10, 20 and 30%, the protein percent were 10.8, 12.5 and 14.4% and crude fiber contents were 1.10, 1.27 and 1.33%, respectively which due to their high quantities in MP **(Okafor *et al.*, 2012).**

Table 5: Effect of supplementation of mushroom powder on protein and dietary fiber contents ((Mean±SD g/100g) in produced biscuits.

Samples	Protein content	Crude fiber content
Sorghum flour 100%	8.9±1.08	0.73±0.09
10 % MP + 90% sorghum flour	10.8±1.13	1.10±0.06
20 % MP + 80% sorghum flour	12.5±2.23	1.27±0.11
30 % MP + 70% sorghum flour	14.4±3.08	1.33±0.23

Where: (MP) = Mushroom powder.

Influence of MP on color characteristics of biscuits

Color characteristic is a major criterion that affects the quality of the final product. Mean color values of biscuit of different treatments are recorded in Table (6).The fortified flours blends showed a difference in color compared to the control (100% sorghum flour). The slight improvement in color was interpreted as an intense color and it was dependant on the fortification level.

Table 6: Color characteristic of biscuit samples.

Samples	*L**	*A**	*B**
Sorghum flour 100%	58.32±4.78	9.52±1.05	20.12±2.22
10 % MP + 90% sorghum flour	53.47±3.17	9.81±1.33	20.76±3.41
20 % MP + 80% sorghum flour	51.01±5.08	10.62±2.18	21.39±3.33
30 % MP + 70% sorghum flour	48.97±2.44	11.13±3.08	21.82±1.87

Where: (MP) = Mushroom powder.

*Each value represents the Mean of three replicate ±SD

Tables (6) shown Hunter values of whiteness (L), redness (a) and Yellow (b) measured for biscuit crust colors. All fortified samples had slightly lower L values for crust than the control and therefore a slightly darker color, it's due to dietary fiber level increased by mushroom powder increased. There results are in coincidence and confirmed with that obtained by **Kenny *et al.,* (2000); Saricoban and Yilmaz (2010) and Abou-Zaid *et al.,* (2014).** Increasing the percentage of added mushroom powder to sorghum flours, led the values of redness (a), Yellow (b) to be slightly increased in all fortified samples. Subjective evaluations confirmed that the mushroom powder biscuits samples were darker, more red (a-values) than control samples. The results showed that the a-values (redness) increased in the fortified biscuit samples with the increasing of mushroom powder level from 10% to 30%. The results are consistent with that obtained by **Eissa *et al.,* (2007).**

Influence of MP on sensory characteristics of biscuit

The effects of mushroom powder supplementation on the sensory characteristics of biscuits are presented in Table (7). With the increase in the level of mushroom powder in the formulation, the sensory scores for color, shape, odor, taste and texture of biscuits decreased and increased sharply. Replacement of sorghum flour with 10, 20 and 30% of MP impaired the taste of biscuits (control samples had 8.5 score), which significantly decreased from 8.5 to 6.3. The control samples had maximum shape and color acceptability, whereas biscuits containing 30% addition of mushroom powder were found to be unacceptable to the panelists in terms of color, shape, odor, and texture. The color, shape, taste, odor, and texture attributes score for control sample was 9.0, 8.3, 8.1, 8.4, and 7.9 respectively, on a 10-point hedonic scale. The color, shape, odor, taste and texture of the 30% levels substitution was rated as poor and was significant differed then the control sample. Similar observations were also reported with supplementation of mushroom flour blends flour with wheat flour as reported by **Eissa, *et al.*, (2007).** Biscuits made from blends containing 20% level of mushroom powder slightly difference at ($p<0.05$) compared to control. The mushroom powder supplemented biscuits with 10 and 20% performed better in distribution of cell resemble the control. From the sensory acceptability rating, it was concluded that mushroom powder could be incorporated up to 20% level in the formation of biscuits without affecting their sensory quality.

Table 7: Sensory evaluation of biscuit as affected by addition of different levels of MP

Samples	Color	Shape	Taste	Odor	Texture	Structure
Sorghum flour 100%	9.0^{a}	8.3^{a}	8.1^{a}	8.4^{a}	7.9^{a}	8.5^{a}
10 % MP + 90% sorghum flour	8.1^{ab}	7.9^{a}	7.0^{b}	7.1^{ab}	7.2^{a}	7.2^{a}
20 % MP + 80% sorghum flour	7.5^{b}	7.6^{ab}	6.1^{c}	6.6^{b}	6.8^{b}	7.0^{ab}
30 % MP + 70% sorghum flour	7.2^{b}	7.2^{b}	5.0^{d}	5.2^{c}	6.1^{b}	6.3^{b}
L.D.S.	0.98	0.82	0.75	1.30	0.88	1.5

Values in the same column followed by the same letter are not significant different at $P \leq 0.05$.

* Non-significant; ** Least Significant Difference

Conclusions:

MP may be blended with sorghum flour at levels as high as 10% without adversely affecting baking performance of biscuit, but with 20% addition of MP the produced samples were acceptable with slightly differences in physical characteristics of biscuits compared to control sample. However, the addition of MP as a source of protein and crude fibers to sorghum flour affected the rheological, color and sensory characteristics of biscuits in various ways. Biscuits containing 20% MP were high in protein, crude fibers and acceptable. The protein and crude fibers composition of these samples plays a very important role in improving rheological, technological and sensory properties of baking products. These studies have shown that MP could be used successfully for enriching the protein content and crude fibers in biscuits without gluten which could be used in nutritional applications for both normal and autism children particularly in the developing countries.

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خصائص الجودة الكيميائية و الريولوجيه لخلطات البسكويت الخالى من الجلوتين المصنع من دقيق الذرة ومسحوق عيش الغراب

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الملخص العربى :

تهدف الدراسة الحالية إلى تقييم إنتاج بسكويت من دقيق الذرة (SF) مع إستبدال مستويات ٠، ١٠، ٢٠، ٣٠٪ من الدقيق بمسحوق فطر عيش الغراب (MP)، ومدى تأثير الإحلال على الخصائص الكيميائيه والريولوجيه و الحسيه للبسكويت الناتج . ولقد أظهرت نتائج التحاليل الريولوجيه للعجين زيادة معنويه فى نسب وقيم إمتصاص الماء ووقت تكون العجين والوقت اللازم لإضعاف العجين فى حين حدث نقص فيما يتعلق بفترة ثبات العجين الناتج بزيادة نسب الإستبدال حتى نسبة٣٠%. كما أظهرت نتائج التحاليل الطبيعيه حدوث إنخفاض تدريجى فى القطر وسمك القصرة والهشاشية للبسكويت الناتج كلما زادت نسب الإستبدال بمسحوق فطرعيش الغراب حتى مستوى٣٠%. وأوضحت نتائج التحاليل الكيميائيه حدوث زيادة فى محتوى البروتين الخام من ٨,٩ الى ١٤,٤٪، والألياف الخام من ٠,٧٣ الى١,٣٣٪ في البسكويت المنتجة كلما زادت نسب الإستبدال بمسحوق فطر عيش الغراب حتى مستوى٣٠%. وعلى الجانب الآخر لم تظهر الخصائص الحسيه للبسكويت الناتج أى فروق معنويه فى جميع الخصائص عند نسبة استبدال الدقيق بمسحوق فطر عيش الغراب بنسبة ١٠% وحدوث انخفاض فى تلك الخصائص بزيادة معدل الإستبدال حتى نسبية ٣٠% على الرغم من قبولة بواسطة المحكمين. لذلك توصى الدراسة بإمكانية إضافة مسحوق فطر عيش الغراب إلى دقيق الذرة بنسبه تصل إلى ١٠٪ إستبدال بدون أي تأثير ملاحظ على الخصائص الحسية البسكويت الناتج، كما يمكن استخدام هذه الإضافه لتحسين الجودة الغذائية للبسكويت وخاصة في البلدان النامية التى تعانى شعوبها فى مراحل سنيه من سوء التغذية، وكذلك مناسب للأشخاص المصابين بأمراض التوحد والاضطرابات الهضمية.