SUPPLEMENTED PRETZELS BY DRIED OYSTER MUSHROOM (*PLEUROTUS FLORIDA*)

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Abstract

Production of pretzels supplemented with different mushroom parts i.e. mushroom fruiting body, mushroom stem and fungal mycelium at levels of 2, 4 and 6 % to wheat flour (72%) were studied. Results indicated the improvement of the pretzel protein quality especially its lysine content when flour was supplemented with different parts of dried oyster mushroom. Moreover, minerals contents were higher in all supplemented pretzel than unsupplemented ones due to the high minerals content of oyster mushroom. Percentage of recommended dietary allowance (% RDA) was calculated for essential amino acid and some other nutrients for children and adults. Calculations indicated that supplemented pretzel with any of the different parts of oyster mushrooms were higher in % RDA than unsupplemented ones. Moreover, the organoleptic evaluation showed similarity between unsupplemented and supplemented pretzel with either dried fruit bodies or stems of oyster mushroom. Thus, it may be recommended that supplementation of flour with either dried fruiting bodies or the worthless stems of oyster mushroom will elevate the nutritive value of flour with no adverse effect on organoleptic qualities.

INTRODUCTION

Baked products are consumed world wide. However, cereal grains contain too little lysine. Therefore supplementation with lysine has improved the protein quality in wheat flour (Howe et al., 1967). Also, fortification of wheat flour with non-wheat proteins has improved the amino acid profiles and subsequently the protein quality (Stark et al., 1975).

Pretzel is one of saltines soda crackers, it is used as a staple food in several countries. The main component of pretzels is flour which represents at least 80% of the finished product. Although Pretzels contain a moderate amount of carbohydrate, amino acids and minerals (calcium and sodium), it dose not contain excessive fat or chemicals as additives. Pretzels are popular snakes for their crispness, flavor and long storage (Matz, 1993).

Mushrooms contain all the essential amino acids, as well as most commonly occurring non-essential amino acids and amides. Lysine is the most abundant essential amino acid in mushrooms. Thus mushroom protein is a valuable addition to

the diets especially when mixed with cereals. The nucleic acid content of oyster mushroom i.e. *Pleurotus* spp. is quite low. Mushroom in general, also, contains significant amounts of phosphorus, sodium, potassium and a lesser amount of calcium (Wang & Li 1985 and Bano & Rajarathnam, 1988).

In this respect, it has been shown that vegetable baby foods supplemented with dried oyster mushroom have better protein quality and quantity together with minerals that satisfy the recommended allowance of FAO (El-Dessouky & Yousef, 2001). It has also been, mentioned that supplemented cookies with dried oyster mushroom were favorable than unsupplemented ones which probably due to its protein quality and higher amounts of important minerals. Moreover, the organoleptic evaluation showed no adverse score parameters when cookies were supplemented with dried oyster mushroom. On the other hand the addition of dried oyster mushroom resulted in reducing stability of dough. The extensibility of the wheat dough decreased (Salama et al., 2002).

The aim of the present study is to evaluate the effect of supplementing wheat flour with different parts of oyster mushroom (cap, stem and mycelium) on the quality and quantity of protein in pretzel. Also, to finding a possible way for a proper utilization of the worthless mushroom stem.

MATERIALS AND METHODS

Mushroom strain

Pleurotus florida (STCPI-10) obtained from Mushroom Lab., Dokki, ARC, was used in this study. The mushroom culture was maintained on PDA slants fortified with 0.3% yeast extract at 4°C.

Production of mushroom fruiting bodies

P. florida wheat spawn was prepared as described by Garcha (1981) and was used to inoculate the wet and pasteurized straw at the level of 3% and incubated in a greenhouse in El-Dokki mushroom farm, ARC, Egypt, (El-Kattan et al., 1991). Mushroom caps were separated from the stems and found to be about 80% of the total yield. Fresh caps and stems were dried at 50°C overnight and saved till utilization.

Production of fungal mycelium

Potato dextrose broth medium was used to produce the fungal mycelium using the method described by Youesf et al. (2005). The produced fungal biomass was washed with distilled water, and then dried at 50°C overnight and saved until utilization.

Pretzel formula

Pretzel formula was prepared basically according to the method described by Matz (1993) with a slight modification. The formula was prepared as follows: flour 100, yeast 3.1, salt 2.24, sugar 2.1, fat 3.2 g, and mixed in 50 ml water. The different dried mushroom samples were milled using 0.5 mm sieves and was added to wheat flour at three tested levels i.e. 2, 4, and 6 g. The dry ingredients in pretzels formula were blended, then added to the liquid and mixed to obtain tough dough. The dough was formulated in a thin sheet and cutting to slide sticks ½ cm in thickness and 10 cm in length. The sticks were dipped in 2% sodium carbonate solution at 100°C for 10 sec. Afterward, the pretzels were picked from the solution and a 2% salt was finally spread. The pretzels were baked in oven at 180°C to reach a golden coating.

Analytical methods

Samples were analyzed for moisture content, crude fiber, fat (ether extract), ash and total nitrogen using microKjeldahl apparatus as described in the A.O.A.C. (1995). Total crude protein was calculated as Nx6.25 for dried oyster mushroom and Nx5.7 for wheat flour. Carbohydrates in dry samples were calculated by difference (Carbohydrate % = 100 - [fat% + crude protein% + fiber% + ash %]). Phosphorus was measured according to Jackson (1958). The minerals were determined according to the method described by A.O.A.C. (1998) using the dry ashing method for the preparation of samples. The Perkin Elmer Model 4100ZI Atomic Absorption spectrophotometery was used for the determination of minerals.

Energy value was calculated (James, 1995) using the following equation:

Energy value (in kcal per 100 g dry weight) =

4 x (% protein) + 9 x (% fat) + 4 x (% carbohydrate).

Amino acid contents were determined in the acid hydrolyzed dried samples with a BECKMAN model 119 CL high-speed amino acid analyzer (Wang & Li, 1985). Lysine content was determined using the ninhydrin colorimetric analysis as described by Rosen (1956). Amino acid score (A.A.S) was calculated as stated in FAO/WHO report (1973).

$$\text{Amino acid score (\%)} = \frac{\text{mg of amino acid in g test protein}}{\text{mg of amino acid in g reference protein}} \times 100$$

It has been indicated, in the same above mentioned reference that lysine concentration in casein, as a reference protein is 55 mg per g of protein.

$$\text{A.A.S. (\%) for lysine} = \frac{\text{mg of lysine in g test protein}}{55} \times 100$$

Recommended dietary allowance (% RDA) was calculated according to Food and Nutrition Board (1989).

$$\% \text{ RDA} = \frac{\text{Value of nutrient in sample of pretzel}}{\text{RDA for the same nutrient}} \times 100$$

Sensory evaluation

The pretzels were sensory evaluated for appearance, color, taste, odor, crispness, and mouth-feel by ten members of Food Technology Research Institute Staff, Agricultural Research Center, Egypt according to McWilliams (1997).

Statistical analysis

Statistical analysis was carried out according to Fisher (1970). Least square difference (LSD) test was used to compare the significant differences between means of treatments (Waller & Duncan, 1969). The statistical package for social science (SPSS, 1999) program version 10 was used for all analysis.

RESULTS AND DISCUSSION

The chemical composition, energy value and mineral contents of raw materials used in this study are presented in Table 1. The highest crude protein content was found in dried fruiting bodies of oyster mushroom followed by dried stems. Ash and fiber were high in all dried parts of oyster mushroom compared with flour. Mineral contents presented in the same Table clearly show that all dried parts of oyster mushroom contained higher amount as compared with flour. These results indicated that dried oyster mushroom is rich in minerals which confirm the data found by El-Kattan et al. (1991).

Amino acid contents of raw materials used in making pretzel are shown in Table (2). It is clearly shown that essential amino acid contents of mycelium, stems and fruit bodies are higher than that present in flour protein.

Table 1. Chemical composition of flour and dried raw parts of mushroom

Chemical constituents	Flour	Mushroom stem	Mushroom fruit bodies	Fungal mycelium
Chemical composition, %				
Moisture content	12.7	6.20	10.30	4.80
Protein	11.21	22.65	27.88	19.33
Fat	1.55	1.30	1.80	0.76
Ash	1.63	8.75	8.98	7.00
Fiber	0.52	11.75	10.52	2.34
Carbohydrate	85.09	55.55	50.82	70.57
Energy value, Kcal/100g DM	399.15	324.50	331.00	366.44
Minerals, mg/100g				
Mg	59.13	187.70	342.19	439.30
Na	119.18	341.77	315.62	542.79
Zn	1.90	23.78	19.55	24.02
Mn	0.42	1.08	5.35	11.14
Fe	5.33	14.59	19.38	25.17
Ca	19.20	30.11	32.30	56.04
K	231.31	1525.15	646.11	2082.76
P	137.58	587.48	637.55	438.75

Table 2. Amino acids content of flour and dried raw parts of mushroom (g amino acid / 100g protein)

Amino acid	Flour	Dried mushroom stem	Dried mushroom fruit bodies	Dried fungal mycelium
Aspartic acid	2.217	6.984	8.027	8.907
Threonine*	1.904	3.517	4.922	4.449
Serine	2.250	3.300	5.636	4.611
Glutamic acid	24.982	9.098	12.318	11.431
Proline	9.354	2.939	3.478	3.591
Glycine	1.919	4.339	4.756	4.260
Alanine	1.818	7.968	7.360	6.146
Cystine	0.045	1.057	1.056	1.044
Valine*	3.124	6.962	6.366	2.468
Methionine*	0.956	3.312	2.562	2.875
Isoleucine*	1.707	5.325	4.227	4.930
Leucine*	4.329	2.789	7.569	1.724
Tyrosine	1.696	3.217	3.409	3.461
Phenylalanine*	2.562	3.702	3.472	4.401
Histidine*	1.216	2.220	2.885	4.893
Lysine*	1.278	6.636	9.885	5.830
Tryptophan*	1.200	1.205	1.158	0.976
Arginine*	1.824	5.379	6.924	4.989
Total essential amino acid	20.10	41.05	49.97	37.54

* Essential amino acid

Data in Table (3) show the chemical composition of unsupplemented and supplemented pretzel with different dried parts of oyster mushroom. Protein, ash and minerals were increased in supplemented pretzel as the added mushroom part was increased. Energy values were almost the same in unsupplemented and supplemented pretzels however, with a slight increase as the additives were increased. Increasing the protein and mineral contents in the different parts of oyster mushroom are expected to improve the quality of the product (pretzel). These results were in agreement with those of Salama et al. (2002) who mentioned that the level of protein and minerals were raised in cookies supplemented with oyster mushroom.

Data presented in Table (4) clearly show that most of the amino acids especially lysine were increased and consequently the protein quality was improved in pretzel when dried oyster mushroom were added.

Data presented in Table (5) show that supplementation of pretzel with dried oyster mushroom increased both the amount of total crude protein content and the quality of the protein evaluated by the increase in its lysine content and score. The highest lysine score reached 31.27 % for pretzel supplemented with 6 % dried fruit bodies followed by pretzel supplemented with either 4 % fruit bodies or 6 % dried stems, which reached 27.82 %.

Lysine score has been elevated as a result of supplementing wheat flour (low lysine content) with the dried oyster mushroom (high lysine content). These results are in agreement with those found by Salama et al. (2002) who obtained similar results when supplemented cookies with dried oyster mushroom.

Data in Tables (6 and 7) show the percentage of the value of nutrient or essential amino acid to the RDA for the same nutrient or essential amino acid. It could be observed that 100 g of supplemented pretzel with 2, 4, and 6 % mushroom stem cover 46.14 to 48.07% of daily protein requirement for children and 22.28 to 23.21% for adults. Moreover, all values of % RDA for some nutrients were higher in supplemented pretzel as compared with unsupplemented ones as shown in Table 6.

The recommended dietary allowance (% RDA) for essential amino acid is presented in Table (7), it can also be seen that 100 g of supplemented pretzel with 6% mushroom fruit bodies cover 13.88 and 27.26 % of the daily total essential amino acid requirement without histidine for children and adults, respectively. These figures are slightly higher than those calculated for pretzel supplemented with 6 % mushroom stems which reached 12.75 and 24.86% of daily total essential amino acid requirement without histidine for children and adults, respectively.

Sensory evaluation of different pretzel is shown in Table (8). It can be seen that addition of dried mycelium to wheat flour for the production of pretzel resulted in

decreasing most of the scores of organoleptic qualities. On the other hand, the unsupplemented pretzel and those supplemented with the three tested levels of both dried stems and fruit bodies of oyster mushroom were similar on all organoleptic properties.

From the above mentioned data, it can be concluded that pretzels may be supplemented with any of the different parts of oyster mushrooms. Moreover, the worthless oyster mushroom stems have improved the nutritive values of pretzel without any negative effect on the organoleptic evaluation which would add value to the oyster mushroom by-products.

Table 3. Chemical composition of supplemented pretzel with the different forms of dried oyster mushroom (*P. florida*)

Chemical constituent	Unsupplemented pretzel	Supplemented with mushroom stem, %			Supplemented with mushroom fruit bodies, %			Supplemented with fungal mycelium, %		
		2	4	6	2	4	6	2	4	6
Chemical composition %										
Moisture content	4.21	4.49	4.62	4.73	4.60	4.67	5.36	4.12	4.10	4.16
Protein	12.61	12.82	13.01	13.20	12.92	13.20	13.46	12.75	12.86	12.97
Ether extract	4.82	4.73	4.68	4.61	4.76	4.70	4.65	4.74	4.65	4.58
Crude Fiber	0.59	0.81	1.02	1.22	0.78	0.97	1.15	0.62	0.65	0.68
Ash	1.83	1.97	2.10	2.22	1.98	2.11	2.24	1.94	2.03	2.12
Carbohydrate	80.15	79.67	79.19	78.75	79.56	79.02	78.50	79.95	79.81	79.65
Energy value, Kcal/100g	414.42	412.53	410.92	409.29	4.12.76	4.11.18	409.69	413.46	412.53	411.70
Minerals, mg/100g										
Mg	59.13	62.89	66.64	70.40	65.98	72.82	79.67	67.92	76.71	85.49
Na	158.46	165.22	171.54	178.97	164.58	171.09	177.40	169.32	180.18	191.03
Zn	1.90	1.98	2.05	2.13	2.29	2.68	3.08	2.38	2.86	3.34
Mn	0.42	0.44	0.46	0.48	0.53	0.63	0.74	0.64	0.86	1.09
Fe	5.33	5.62	5.913	6.21	5.72	6.10	6.49	5.83	6.34	6.84
Ca	19.20	19.80	20.40	21.00	19.842	20.49	21.13	20.32	21.44	22.56
K	231.31	261.81	292.32	322.82	244.23	257.16	270.08	272.97	314.62	356.28
P	137.58	149.33	161.08	172.83	150.33	163.08	175.80	146.36	155.13	175.83

Table 4. Amino acids of supplemented pretzel with the different forms of dried oyster mushroom (*P. florida*)

Amino acids*	Unsupplemented pretzel	Supplemented with mushroom stem, %			Supplemented with mushroom fruit bodies, %			Supplemented with fungal mycelium, %		
		2	4	6	2	4	6	2	4	6
Aspartic acid	1.97	2.11	2.25	2.39	2.13	2.29	2.45	2.15	2.33	2.50
Therionine	1.69	1.76	1.83	1.90	1.79	1.89	1.99	1.78	1.87	1.96
Serine	2.00	2.07	2.13	2.20	2.11	2.23	2.34	2.09	2.18	2.28
Glutamic	22.20	22.38	22.56	22.75	22.45	22.69	22.94	22.43	22.66	22.89
proline	8.32	8.38	8.44	8.50	8.39	8.46	8.53	8.39	8.46	8.54
Glycine	1.70	1.79	1.87	1.96	1.80	1.89	1.99	1.79	1.87	1.96
Alanine	1.61	1.77	1.93	2.09	1.76	1.90	2.05	1.73	1.86	1.98
Cystine	0.04	0.06	0.08	0.10	0.06	0.08	0.10	0.06	0.08	0.10
Valine	2.78	2.92	3.06	3.20	2.91	3.03	3.16	2.83	2.88	2.93
Methionine	0.85	0.92	0.98	1.05	0.90	0.95	1.00	0.91	0.97	1.02
Isoleucine	1.51	1.62	1.72	1.83	1.59	1.68	1.76	1.61	1.71	1.81
Leucine	3.85	3.91	3.96	4.02	4.00	4.15	4.30	3.88	3.92	3.95
Tyrosine	1.51	1.57	1.64	1.70	1.59	1.65	1.71	1.58	1.65	1.72
Phenylalanine	2.28	2.35	2.43	2.50	2.35	2.42	2.49	2.37	2.46	2.54
Histidine	1.08	1.12	1.17	1.21	1.14	1.20	1.25	1.18	1.28	1.37
Lysine	1.13	1.26	1.40	1.53	1.33	1.53	1.72	1.25	1.36	1.48
Tyryptohpan	1.07	1.09	1.12	1.14	1.09	1.12	1.14	1.09	1.11	1.13
Arginine	1.62	1.73	1.84	1.94	1.76	1.90	2.04	1.72	1.82	1.92

* g amino acid/100 g protein

Table 5. Effect of supplementing wheat flour with three percentages of different parts of dried oyster mushroom (*P. florida*) on protein quality and quantity of pretzel

Product	Crude protein, %	Lysine, mg/g protein	Lysine score, %
Raw materials:			
Flour	11.21	12.78	23.24
Stem	22.65	66.36	120.65
Fruit bodies	27.88	98.85	179.73
Mycelium	19.33	58.30	106.0
Baked Pretzel			
Unsupplemented	12.61	11.3	20.55
Supplemented pretzel with:			
2% stem	12.82	12.6	22.91
4% stem	13.01	14.0	25.45
6% stem	13.20	15.3	27.82
2% fruit body	12.92	13.3	24.18
4% fruit body	13.20	15.3	27.82
6% fruit body	13.47	17.2	31.27
2% mycelium	12.75	12.5	22.73
4% mycelium	12.86	13.6	24.73
6% mycelium	12.97	14.8	26.91

Table 6. Percentage of RDA for some nutrients provided from 100 g of pretzel for children and adults

Age group	Nutrients	Daily recommended	% RDA*								
			Unsupplemented	Supplemented with mushroom stem, %			Supplemented with mushroom fruit bodies, %			Supplemented with fungal mycelium, %		
				2	4	6	2	4	6	2	4	6
Children 7-10 year	Energy, Kcal	2000	20.72	20.63	20.55	21.46	20.64	20.56	20.48	20.67	20.63	20.59
	Protein, g	28	45.04	45.79	46.46	47.14	46.14	47.14	48.07	45.53	45.93	46.32
	Ca, mg	800	2.40	2.47	2.55	2.63	2.48	2.56	2.64	2.54	2.68	2.83
	Mg, mg	170	34.78	37.00	39.20	41.41	38.81	42.84	46.86	39.95	45.12	50.29
	Zn, mg	10	19.02	19.78	20.53	21.29	22.93	26.84	30.75	23.82	28.63	33.43
	Fe, mg	10	53.29	56.21	59.13	62.05	57.17	61.04	64.92	58.32	63.36	68.39
	P, mg	800	17.20	18.67	20.14	21.60	18.79	20.39	21.98	18.30	19.39	21.98
Adults 19-24 year	Energy, Kcal	2900	14.29	14.23	14.17	14.11	14.23	14.18	14.13	14.26	14.23	14.20
	Protein, g	58	21.74	22.10	22.43	22.76	22.28	22.76	23.21	21.98	22.17	22.36
	Ca, mg	1200	1.60	1.65	1.70	1.75	1.65	1.71	1.76	1.69	1.79	1.88
	Mg, mg	350	16.90	17.97	19.04	20.11	18.85	20.81	22.76	19.41	21.92	24.43
	Zn, mg	15	12.68	13.20	13.67	14.20	15.27	17.87	20.53	15.87	19.07	22.27
	Fe, mg	10	53.29	56.21	59.13	62.05	57.17	61.04	64.92	58.32	63.36	68.39
	P, mg	1200	11.47	12.44	13.42	14.40	12.53	13.59	14.65	12.20	12.93	14.65

$$*\%\ RDA = \frac{\text{Nutrient content of 100 g sample}}{\text{RDA for the same nutrient}} \times 100$$

Table 7. Percentage of RDA for essential amino acid provided from 100 g of pretzel for children and adults

Age group	Essential amino acid	Recommended mg/day	% RDA*								
			Unsupplemented	Supplemented with mushroom stem, %			Supplemented with mushroom fruit bodies, %			Supplemented with fungal mycelium, %	
				2	4	6	2	4	6	2	4	6
Children 7-10 year	Histidine	--	--	--	--	--	--	--	--	--	--	--
	Isoleucine	28	0.68	0.75	0.82	0.89	0.79	0.89	1.00	0.75	0.82	0.89
	Leucine	42	1.15	1.17	1.19	1.20	1.19	1.23	1.27	1.27	1.32	1.40
	Lysine	44	0.32	0.38	0.43	0.48	0.41	0.49	0.57	0.43	0.53	0.63
	Methionine + cystine	22	0.51	0.58	0.63	0.71	0.62	0.73	0.84	0.59	0.65	0.73
	Phenylalanine + tyrosine	22	2.17	2.30	2.45	2.58	2.35	2.52	2.70	2.51	2.45	2.59
	Thereonine	28	0.76	0.82	0.88	0.95	0.83	0.90	0.97	0.84	0.92	1.00
	Tryptophan	3.3	4.09	4.21	4.33	4.42	4.30	4.48	4.70	4.24	4.42	4.58
	Valine	25	1.40	1.44	1.48	1.52	1.52	1.71	1.83	1.52	1.63	1.75
	Total without histidine	214	11.08	11.65	12.21	12.75	12.01	12.95	13.88	12.15	12.74	13.57
Adults 19-24 year	Histidine	12	1.13	1.29	1.45	1.60	1.23	1.34	1.44	1.24	1.35	1.46
	Isoleucine	10	1.91	2.10	2.29	2.48	2.20	2.50	2.80	2.10	2.29	2.48
	Leucine	14	3.46	3.51	3.56	3.60	3.58	3.69	3.80	3.80	3.96	4.20
	Lysine	12	1.19	1.38	1.57	1.76	1.50	1.81	2.11	1.57	1.93	2.31
	Methionine + cystine	13	0.86	0.98	1.07	1.21	1.05	1.24	1.42	0.99	1.11	1.24
	Phenylalanine + tyrosine	14	3.41	3.62	3.84	4.06	3.69	3.96	4.24	3.95	3.85	4.07
	Thereonine	7	3.04	3.29	3.53	3.79	3.31	3.60	3.89	3.36	3.69	4.00
	Tryptophan	3.5	3.86	3.97	4.09	4.17	4.06	4.23	4.43	4.00	4.17	4.31
	Valine	10	3.50	3.59	3.69	3.79	3.79	4.28	4.57	3.79	4.08	4.37
	Total without histidine	84	21.23	22.44	23.64	24.86	23.18	25.31	27.26	23.56	25.08	26.98

$$* \% RDA = \frac{\text{Amino acid content of 100 g pretzel}}{\text{RDA for the same amino acid}} \times 100$$

Table 8. Sensory evaluation of supplemented pretzel with the different forms of the dried oyster mushroom (*P. florida)*

Parameters	Unsupplemented pretzel	Supplemented with mushroom stem, %			Supplemented with mushroom fruit bodies, %			Supplemented with fungal mycelium, %		
		2	4	6	2	4	6	2	4	6
Appearance (10)	9.00^{a} ± 1.07	9.13^{a} ± 0.83	8.80^{ab} ± 1.01	8.80^{ab} ± 0.77	7.47^{cd} ± 1.19	8.13^{abc} ± 1.06	7.00^{cd} ± 1.31	7.67^{bc} ± 2.29	7.47^{cd} ± 1.77	6.33^{e} ± 2.19
Color (10)	8.93^{ab} ± 1.22	9.27^{a} ± 0.79	8.73^{abc} ± 1.03	8.60^{abc} ± 1.35	7.73^{cd} ± 1.09	8.07^{bcd} ± 1.03	7.13^{de} ± 1.64	8.13^{bcd} ± 1.55	7.80^{bcd} ± 1.47	6.33^{e} ± 2.32
Taste (25)	21.27^{ab} ± 3.59	21.93^{a} ± 2.31	19.40^{abc} ± 5.54	19.40^{abc} ± 4.97	18.53^{abc} ± 4.81	19.07^{abc} ± 4.86	18.20^{abc} ± 5.32	17.27^{bc} ± 6.75	17.20^{bc} ± 6.78	15.67^{c} ± 5.72
Odor (25)	22.33^{a} ± 2.13	21.73^{ab} ± 2.96	20.80^{ab} ± 5.95	20.27^{ab} ± 4.71	21.20^{ab} ± 2.68	20.20^{ab} ± 3.38	21.13^{ab} ± 1.77	18.73^{ab} ± 6.34	19.33^{ab} ± 5.01	19.47^{ab} ± 4.19
Mouth feel (15)	13.27^{a} ± 1.87	13.27^{a} ± 2.15	13.20^{a} ± 2.57	12.53^{ab} ± 3.11	11.87^{abc} ± 2.13	11.47^{abcd} ± 1.68	11.20^{bcd} ± 1.93	11.53^{cd} ± 3.52	9.73^{d} ± 3.01	10.20^{cd} ± 1.74
Crispness (15)	14.20^{a} ± 1.47	14.2^{a} + 1.69	13.73^{ab} ± 1.91	14.33^{a} ± 1.91	13.47^{ab} ± 1.36	13.20^{ab} ± 1.01	12.27^{bc} ± 3.49	10.87^{c} ± 2.26	12.33^{bc} ± 3.09	12.73^{ab} ± 1.91

a, b, c, ... means in the same row within the same item followed by different superscripts differ significantly at $P< 0.05$.

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المقرمشات المملحة المدعمة بعيش الغراب المحارى (*Pleurotus florida*)

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تم دراسة وتقييم الـ pretzel (المقرمشات المملحة) المدعمة بأجزاء مختلفة من عيش الغراب مثل السيقان والثمار والميسليوم المضافة بنسب ٢، ٤، ٦ % إلى دقيق القمح استخلاص ٧٢ %. أوضحت النتائج تحسن فى صفات جودة البروتين للمقرمشات المملحة المدعمة بكل الأجزاء من عيش الغراب المستخدم حيث زاد محتوى الليسين وكذلك محتوى المعادن للمقرمشات المملحة المدعمة عن الغير مدعمة نتيجة لزيادة محتوى الليسين والمعادن فى كل أجزاء عيش الغراب.

وتم حساب الاحتياجات اليومية لبعض العناصر الغذائية والأحماض الأمينية الأساسية للأطفال والبالغين وأوضحت النتائج أن المقرمشات المملحة المدعمة بأجزاء عيش الغراب المختلفة أدت إلى زيادة النسبة المئوية للمحتوى الغذائى من المعادن والحامض الأمينى (ليسين) منسوباً إلى RDA لنفس المكون فى اليوم للأطفال والبالغين عند تناولها عن المقرمشات المملحة الغير مدعمة. أوضحت نتائج التقييم الحسى تشابه المقرمشات المملحة الغير مدعمة والمدعمة بالسيقان والثمار المجففة.

ويمكن التوصية بتدعيم دقيق القمح بالثمار أو السيقان المجففة الغير مستغلة من عيش الغراب المحارى وذلك لرفع القيمة الغذائية مع عدم حدوث تغير فى التقييم الحسى.