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انتاج مكرونه عالية البروتين

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الملخص العربي

نظرا لأهمية المكرونة كغذاء شعبي، فقد تم دراسة تأثير استبدال السيمولينا بنسب ١٠، ٢٠، ٣٠، ٤٠، ٥٠% بجلوتين الأذرة على التركيب الكميائي والخواص الطبيعية و التكنولوجية والمحتوى من العناصر المعدنية والتقييم الحسي وكذلك التخزين لمدة ١٨٠ يوم للمكرونة، ولقد أوضحت النتائج أن زيادة نسبة استبدال السيمولينا بجلوتين الأذرة أحدثت زيادة معنوية للبروتين والرماد والدهون والسعرات الحرارية بينما حدث نقص معنوى فى الألياف والكربوهيدرات. كما أظهرت العناصر المعدنية باستثناء عنصر البوتاسيوم زيادة واضحة بزيادة نسبة استبدال السيمولينا بجلوتين الأذرة. أضافة جلوتين الأذرة إلى السيمولينا في صناعة المكرونة يحسن من خواص الطبخ مثل نسبة الزيادة فى الحجم، بينما يقلل من نسبة الزيادة فى الوزن. وكذلك وجد أن زيادة إضافة جلوتين الأذرة حتى نسبة ٤٠% كانت مقبولة معنويا بالنسبة للتقييم التكنولوجي و الحسي. كما لوحظ أنه عند تخزين المكرونة المدعمة بالبروتين بإضافة جلوتين الأذرة على درجة حرارة الغرفة (٢٥م° ±١)، وجد عدم حدوث تغير فى التقييم الحسي حتى ١٥٠ يوم من التخزين. ومن هذا يمكن القول بأن استبدال السيمولينا بجلوتين الأذرة حتى نسبة ٤٠% استبدال، تؤدى إلى تحسين التركيب الكميائي، والخواص الطبيعية ، و التكنولوجية، والحسية، والمحتوى من العناصر المعدنية للمكرونة الناتجة من قمح الديورم (السيمولينا).

PRODUCING OF HIGH PROTEIN MACARONI

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ABSTRACT: ***The effect of replacing semolina with different levels (10, 20, 30, 40 and 50%) of corn gluten meal (CGM) on the proximate chemical composition, physical properties, minerals content and sensory properties as well as the storage ability of the produced high protein macaroni were investigated. Generally, increasing the levels of CGM significantly (P ≤ 0.05) increased protein, ash, fat and caloric values; however fiber and carbohydrates contents were decreased. The minerals content (except K) were progressively increased by increasing the levels of CGM from 10% to 50%. The replacement of CGM increased (P ≤ 0.05) the percentage of volume increase and decreased (P ≤ 0.05) the percentage of weight increase, however, cooking loss was increasing. Sensory properties of the high protein macaroni were improved (P ≤ 0.05) by increasing the replacement level up to 40 %. It could be stored at room temperature (25 º C ± 1) up to 120 days without significant decrease in the sensory properties. The results of this study support the increased utilization of corn gluten meal for food uses.***

Key Wards***: High protein macaroni, corn gluten meal, sensory properties, cooking loss.***

INTRODUCTION

Macaroni is an inexpensive food usually made from wheat, which is consumed in most countries worldwide. However, it is rather low in protein (<15%) and is relatively deficient in lysine. This is particularly important for efforts to nourish the hungry using pasta as the primary source of calories and protein. Pastas and breads made from low-protein grains make up a sizeable portion of diets among the undernourished in some countries in Africa and Asia. Even in the U.S.A, diets deficient in protein occur among the poor who sometimes depend on low-cost breads and pastas for nutrition (Shogren *et al*., 2006). There is an increasing interest among vegetarians and health-conscious people to consume protein-enriched foods from plant sources, which have no cholesterol and low saturated fat content in general. Therefore, there have been many studies to supplement macaroni with proteins rich in lysine, such as soy protein (Siegel *et al*., 1975; Laignelet *et al*., 1976; Haber *et al*., 1978; Buck *et al*., 1987; Taha *et al*., 1992; Collins and Pangloli 1997 and Ugarcic-Hardi *et al*., 2003), fish protein concentrate (Kwee *et al*., 1969 and Sidwell *et al*., 1970), legumes and their protein concentrates (Bahnassey and Khan 1986 and Bahnassey *et al*., 1986), corn distillers' dried grains (Wu *et al*., 1987), and corn gluten meal (Wu *et al*., 2001).

The objective of this study was to investigate the proximate chemical composition, mineral contents, cooking quality, sensory properties and storage ability of high protein macaroni produced by replacing with different levels (10, 20, 30, 40 and 50%) of corn gluten meal (CGM).

MATERIALS AND METHODS

1. Materials

Durum wheat kernels, variety Beny-Sweef-1 were obtained from wheat breading Research Sector, Field Crops Research Institute Agricultural Research Center, Giza, Egypt. Corn gluten meal (CGM), was obtained from Egyptian company of Starch and Glucose, Turh Factory, Cairo, Egypt. Multilayer flexible packages were obtained from Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

2. Methods

2.1. Technological methods

2.2.1.1. Preparation of dried corn gluten meal (CGM)

Corn gluten meal (CGM), was milled using laboratory disc mill, sieved on a 0, 60 mm Sieve, softened in cyclone mill, and sieved on a 50 - 60 mesh sieve. The flours were packed in polyethylene bags and kept at 3 - 5 ^{o}C until use.

2.1.2. Preparation of Semolina

Durum wheat kernels were cleaned, conditioned to 15 % moisture content by soaking in tap water for 4 hours, then milled using semolina machine (model No.279002, Germany) at the Crops Technology Research Section, Food Technology Research Institute, Giza, Egypt. Semolina granules size were 150 - 450 mm. kept in tight container at 3 - 5 ^{o}C through this study.

2.1.3. Preparation of high protein macaroni

Macaroni was made in laboratory vacuum mixer machine (model De. Ma. Co. De Francis Machine Corporation), according to the method described by EL-Adly (2004) In brief,

One kg of each blend of raw materials was mixed with the required amount of water 300ml. After the complete addition of water, mixing was continued at moderate speed for 8 min. The premixed dough was then placed in the vacuum mixer and extender at rate of 21 rpm, temperature 25^{o}C and vacuum 45cm Hg/Cm^{2} .The obtained dough was then progressed from the extruding auger to the macaroni die. Extension tube was added to ensure uniform hydration of the macaroni dough prior to extrusion. The macaroni was dried at 40 ^{o}C for 29 h. then packed in polyethylene bags and stored at room temperature 25 º C ± 1 for 180 day.

2.2. Chemical analysis

2.2.1. Proximate chemical composition

Moisture, ash, total nitrogen, crude fat and crude fiber of semolina flour and corn gluten meal (CGM) ware determined by the methods described in A.O.A.C. (2005). Total carbohydrates were calculated by difference.

2.2.2. Minerals contents

Mg, Na, Zn, Mn, Fe, Ca and K were determined using a pye Unicom SP 19000 Atomic Absorption Spectroscopy Technology in Agriculture Research Center, Giza, Egypt as described by A.O.A.C (2005).

2.3. Functional properties

2.3.1. Water and oil holding capacity

Water holding capacity (W.H.C.) and oil absorption capacity (O.A.C.) were determinate according to Knuckles and Kohler (1982).

2.3.2. Hardness

The force required to break the macaroni was measured according to the method of Gomez-Aldapa *et al.*, (1999) by using the digital force gauge (model FGN-50, Japan). The probe was carried out using a chisel knife. The macaroni was placed on plate with a hole located at the center of the plate. The maximum force required to break the macaroni was reported in Neutin (N).

2.4. Caloric value

Caloric value of final product (macaroni) was calculated according to Eneche (1999) by multiplying the proportions of protein, fat and digestible carbohydrate by their respective physiological fuel values of 4, 9 and 4 kcal/g, respectively.

2.5. Cooking quality of Macaroni

The cooking quality *i.e.* (the percentage of weight increase, the percentage of volume increase and cooking loss) of all macaroni samples were measured using the method described by Walsh and Gills (1971) as follows:

2.5.1. Percentage of weight increase

Percentage increase was measured by cooking 10 gm of each sample for 10 minutes in 300 ml boiling water. After cooking the samples was drained, rinsed and weighted. The weight increased percentage was calculated as follows:

$$\text{Weight increase (\%)} = \frac{\text{Weight of cooking sample- weight of uncooked sample}}{\text{Weight of uncooked sample}} \times 100$$

2.5.2. Percentage of volume increase

Percentage of volume increasing (swelling %) was measured using petroleum naphtha in measuring sample volume by measured the volume of cooked and uncooked macaroni.

$$\text{Volume increase (\%)} = \frac{\text{Volume of cooked sample} - \text{Volume of uncooked sample}}{\text{Volume of uncooked sample}} \times 100$$

2.5.3. Cooking loss

Total soluble solids in the cooking liquor were determined according to the method of Walsh and Gilles (1971) and El-Adly (2004); as follows 10 gm. of each macaroni sample was cooked for 10 minutes in 300 ml boiling water then drained. The drained liquor was evaporated to dryness and weight. The cooking loss was calculated as:

$$\text{Cooking loss (\%)} = \frac{\text{Weight of dried residue in cooking water}}{\text{Weight of uncooked sample}} \times 100$$

2.6. Sensory evaluation of macaroni

Appearance (20), color (20), taste (20), odor (20), stickiness (20) and overall acceptability (100), of the cooked macaroni were sensory evaluated as described by Matz, (1969). Sensory evaluation was performed by ten panelists of Food Technology Research Institute, Giza, Egypt.

2.7. Statistical analysis

The experimental data were analyzed using Analysis of Variance (ANOVA) followed by Duncan's multiple range tests (P ≤0.05) to determine a significant difference among samples. The data were analyzed according to User's Guide of Statistical Analysis System SAS, (1996) at the Computer Center, Faculty of Agriculture, Ain-Shams, University, Cairo, Egypt.

RESULTS AND DISCUSSION

1. Proximate chemical composition of raw materials

The proximate chemical composition (on dry weight basis) of semolina flour and corn gluten meal (CGM), are presented in table (1). The CGM had the highest value of protein 72.42%, fat contents 7.48% and ash content 1.44% respectively, meanwhile, semolina had the highest value of fiber and total carbohydrates contents 4.86 and 78.30% respectively. These results are in accordance with those obtained by Hussein, (1998) who stated that the corn gluten contained 10.2% moisture, 60% protein, 4% fat, 5.2% ash, 6.1% fiber, and 14.5% carbohydrates. Farag, (2003) stated that the corn protein concentrate contained 9.23% moisture, 51.58% protein, 5.27% fat, 3.35% ash, 3.17% fiber, and 36.63% carbohydrates. Also Mobarak, (2005) stated that the

semolina (Beny-Sweef-1) contained 14.2% protein 1.75 % fat and 0.73% ash, 4.0% fiber and 79.47% carbohydrates.

CGM had higher values of mineral content as compared with semolina flour (Table 1). Farag, (2003) mentioned that corn protein concentrate contains 398.47 mg/100g potassium, 50.26 mg/100g calcium, 405.28 mg/100g magnesium, 9.72 mg/100g iron, 5.53 mg/100g zinc, 3.26 mg/100g manganese and 94.75 mg/100g sodium.

The oil absorption capacity and water holding capacity of CGM was 108.23 oil/100 g samples and 121.06 water/100 g samples respectively, (Table 1). The destruction of this rigid structure could increase the size of interstitial spaces within the cell wall material and facilitate the hydration of cell wall components. According to various authors (Gould 1984, Gould *et al*., 1989 and Jasberg *et al*., 1989), alkaline hydrogen peroxide removed lignin by solublization, while at the same time modifying cellulose crystallinity and increasing water absorption. Ning *et al*., (1991); stated that the modification of water absorption capacity may be partially due to the swelling of the physical structure of the fiber by alkaline. The water holding capacity in high dietary fiber sources depend on their chemical and physical structure. (Mongeau and Brassard, 1982).

Table (1): Proximate chemical composition, mineral contents (on dry weight basis) and functional properties of semolina and corn gluten meal flour:-

Parameters	Corn gluten meal (CGM)	Semolina
Proximate chemical composition Moisture (%)	7.85	12.25
Protein (%)	72.42	14.52
Fat (%)	7.48	0.91
Ash (%)	1.44	1.41
Crude fiber (%)	0.36	4.86
Carbohydrates (%)	18.30	78.30
mineral contents		
Sodium (Na) mg/100gm	98.76	30.64
Potassium (K) mg/100gm	418.54	398.86
Calcium (Ca) mg/100gm	52.35	17.29
Magnesium (Mg) mg/100gm	412.85	124.26
Iron (Fe) mg/100gm	9.98	6.48
Zinc (Zn) mg/100gm	5.89	2.64
Manganese (Mn) mg/100gm	3.76	1.59
functional properties		
Water holding capacity (g w \100g sample)	121.06	–
Oil absorption capacity (g oil \100g sample)	108.23	–

Calculated by difference

2. Cooking quality of high protein macaroni

Percentage of volume increase, Percentage of weight increase, cooking loss and hardness of high protein macaroni prepared by replacing semolina with different levels (10, 20, 30, 40 and 50%) of corn gluten meal are showed

in Table (2). The percentage of volume increase was significantly (P ≤ 0.05) increased by increasing the level of CGM. On the other hand, percentage of weight increase showed in opposite effect. Macaroni prepared with 40% CGM had higher (P ≤ 0.05) cooking loss than control and other treatments. The hardness of high protein macaroni did not significantly (P > 0.05) affect by CGM levels. Cooking loss of spaghetti was unchanged when corn gluten meal was added except the loss was higher for spaghetti with 10% regular corn gluten meal (Wu *et al*., 2001). Normally, the cooked weight is 3 times the dry weight of the spaghetti, and the cooking loss should not exceed 7-8% of the dry weight (Dick and Youngs, 1988). The firmness of cooked spaghetti was lower with the addition of corn gluten meal (Wu *et al*., 2001).

Table (2): Cooking quality of high protein macaroni prepared by replacing semolina with different levels of corn gluten meal

Replacing levels (%)	Percentage of volume increase	Percentage of weight increase	Cooking loss (T.S.S.) (%)	Hardness (N)
0	70.13[f] ±0.09	142.76[a] ±0.05	8.47[e] ±0.06	0.1855[ab] ±0.006
10	73.71[e] ±0.12	135.87[b] ±0.05	7.57[f] ±0.05	0.198[ab] ±0.004
20	79.06[d] 0.08	126.61[c] 0.06	10.41[d] ±0.05	0.251[a] ±0.055
30	80.84[c] ±0.08	123.65[d] ±0.06	11.72[c] ±0.05	0.205[ab] ±0.021
40	86.42[b] ±0.05	115.80[e] ±0.05	13.48[a] ±0.05	0.189[ab] ±0.01
50	87.87[a] ±0.06	113.78[f] ±0.05	12.70[b] ±0.06	0.182[b] ±0.009
L.S.D.	0.19	0.14	0.14	0.06

 # Each value mean of three replicates ± SD, means in the same column with different letters are significantly different at (p≤0.05).

3. Proximate chemical composition of high protein macaroni

The changes in the proximate chemical composition of high protein macaroni prepared by replacing semolina by different levels (10, 20, 30, 40 and 50%) of corn gluten meal are presented in Table (3). The protein contents were significantly (P ≤ 0.05) increased by increasing level of CGM from 10% to 50% (18.34 – 41.51%) compared to control (12.69%). Fat and caloric values were significantly (P ≤ 0.05) increased by increasing the CGM replacement levels compared to the control. Fat and ash contents were significantly (P ≤ 0.05) increased by increasing the CGM replacement level compared to the control. While, carbohydrate showed in opposite trend. The similar trends were observed in moisture, ash and fiber contents. Wu *et al*., (2001) stated that protein content of uncooked spaghetti increased by 23% from 14.1 to 17.4% when semolina were blended with 5% water/ethanol-washed corn gluten meal.

Table (3): Proximate chemical composition and caloric values of high protein macaroni prepared by replacing semolina with different levels of corn gluten meal

	Replacing levels (%)						L.S.D.
	0	10	20	30	40	50	
Moisture (%)	8.48 [a] ±0.04	7.77 [b] ±0.02	7.64 [cd] ±0.04	7.75 [bc] ±0.05	7.55 [d] ±0.04	6.65 [e] ±0.04	0.11
Protein (%)	12.69 [f] ±0.02	18.34 [e] ±0.04	24.14 [d] ±0.05	29.85 [c] ±0.05	34.63 [b] ±0.07	41.51 [a] ±0.06	0.13
Ash (%)	0.85 [d] ±0.04	0.94 [d] ±0.04	1.06 [bc] ±0.03	1.05 [c] ±0.05	1.16 [ab] ±0.02	1.17 [a] ±0.02	0.09
Fat (%)	1.16 [f] ±0.02	2.84 [e] ±0.04	3.04 [d] ±0.04	4.45 [c] ±0.04	5.49 [b] ±0.04	7.03 [a] ±0.03	0.10
Crude fiber (%)	4.75 [a] ±0.05	4.35 [b] ±0.04	3.92 [c] ±0.04	3.55 [d] ±0.04	3.04 [e] ±0.06	2.67 [f] ±0.06	0.13
Carbohydrates (%)	80.55 [a] ±0.01	73.53 [b] ±0.07	67.84 [c] ±0.05	61.10 [d] ±0.07	55.23 [e] ±0.07	47.64 [f] ±0.11	0.18
Caloric values kcal/100g (wet basis)	383.40 [f] ±4.65	393.04 [e] ±0.08	395.28 [d] ±0.11	403.85 [c] ±0.04	412.90 [b] ±0.49	419.87 [a] ±0.02	4.68

 # Each value is mean of three replicates ± SD, means in the same row with different letters are significantly different at ($p \leq 0.05$).
Calculated by difference.

4. Mineral contents of high protein macaroni

Mineral contents in control macaroni as well as high protein macaroni are showed in Table (4). Potassium content was decreased by increasing the level of CGM. These results may be due to the high amounts of Potassium in the semolina than CGM. Sodium, Calcium, Magnesium, Iron, Zinc and Manganese contents were increased by increasing the level of CGM. The increase in the mineral content may by due to that the CGM contents higher amount of all mineral than semolina.

Table (4): Mineral contents (mg/ 100g dry weight basis) of high protein macaroni prepared by replacing semolina with different levels of corn gluten meal

Replacing levels (%)	Na	K	Ca	Mg	Fe	Zn	Mn
0	35.28	411.41	20.49	146.43	5.95	2.20	1.45
10	41.23	410.12	23.47	172.32	6.33	2.53	1.64
20	47.17	408.82	26.44	198.21	6.70	2.87	1.81
30	53.13	407.53	29.42	224.08	7.09	3.20	1.99
40	59.07	406.34	32.40	249.97	7.46	3.53	2.17
50	65.02	404.94	35.28	275.86	7.84	3.87	2.36

5. Sensory evaluation of high protein macaroni.

Sensory properties of high protein macaroni prepared by replacing semolina with different levels of CGM are represented in Table (5). Appearance, taste, odor and stickiness were not significant ($P > 0.05$)

affected by CGM level. Macaroni prepared with 20 and 30% replacer level had a higher (P ≤ 0.05) color score than the control. However, at lower (10%) and higher (40 and 50%) replacer level macaroni had similar (P > 0.05) color score as the control. Overall acceptability of macaroni was not significantly (P > 0.05) affected by CGM level except 20% replacer level which had a higher (P ≤ 0.05) overall acceptability score than the control. Wu *et al*., (2001) reported that color of semolina was darker (lower L value) and more yellow (higher b value) as water/ethanol-washed corn gluten meal was added to semolina.

3.6. Storage of high protein macaroni at room temperature for 180 days.

Table (5): Sensory properties of high protein macaroni prepared by replacing semolina with different levels of corn gluten meal.

Sensory properties	Replacing levels (%)						L.S.D.
	0	10	20	30	40	50	
Appearance (20)	18.5[a] ±0.66	18.75[a] ±0.69	18.4[a] ±.1.03	18.65[a] ±0.82	18.55[a] ±0.76	18.55[a] ±0.72	0.71
Color (20)	17.65[b] ±0.47	17.9[b] ±0.73	18.6[a] ±0.69	18.65[a] ±0.62	18.2[ab] ±0.86	17.7[b] ±0.79	0.63
Taste (20)	17.95[ab] ±0.89	18.45[a] ±0.68	18.65[a] ±0.79	18.3[a] ±0.59	18.0[ab] ±0.94	17.4[b] ±0.73	0.70
Odor (20)	18.0[ab] ±0.91	17.63[b] ±1.02	18.7[a] ±0.67	18.5[a] ±0.60	18.35[ab] ±1.02	18.0[ab] ±0.88	0.77
Stickiness (20)	18.25[a] ±0.69	18.25[a] ±1.08	18.25[a] ±1.25	18.35[a] ±0.69	18.0[a] ±0.74	17.55[a] ±1.33	0.90
Overall acceptability (100)	90.35[bc] ±1.96	90.98[abc] ±2.82	92.6[a] ±2.83	92.25[ab] ±2.24	91.1[abc] ±1.78	89.2[c] ±1.51	2.01

 # Each value is mean of three replicates ± SD, means in the same row with different letters are significantly different at (p≤0.05).

The effect of replacing semolina with different levels (10, 20, 30, 40 and 50%) of corn gluten meal (CGM) on sensory attributes of the produced high protein macaroni are represented in Table (6). Generally no significant (P > 0.05) differences were observed in the appearance of the different CGM replacement concentrations up to 40 % replacement level. On the other side, color, taste, odor, stickiness and over all acceptability did not affect significantly (P > 0.05) up to 30 % replacement level.

The effects of storage at room temperature (25 º C ± 1) for 180 days on the sensory properties of high protein macaroni are represented in table (6). No significant (p > 0.05) differences were observed in color and stickiness after storage for 150 days, also no significant (p >0.05) change were noticed in the macaroni taste before 120 days. On the other side, odor and overall acceptability changed significantly after 90 days of storage meanwhile, the appearance of macaroni have no significant changes (p >0.05) up to 150 days.

Table 6

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الملخص العربي

نظرا لأهمية المكرونة كغذاء شعبي، فقد تم دراسة تأثير استبدال السيمولينا بنسب ١٠،٢٠،٣٠،٤٠،٥٠% بجلوتين الأذرة على التركيب الكيميائي والخواص الطبيعية و التكنولوجية والمحتوى من العناصر المعدنية والتقييم الحسي وكذلك التخزين لمدة ١٨٠ يوم للمكرونة، ولقد أوضحت النتائج أن زيادة نسبة استبدال السيمولينا بجلوتين الأذرة أحدثت زيادة معنوية للبروتين والرماد والدهون والسعرات الحرارية بينما حدث نقص معنوى فى الألياف والكربوهيدرات. كما أظهرت العناصر المعدنية باستثناء عنصر البوتاسيوم زيادة واضحة بزيادة نسبة استبدال السيمولينا بجلوتين الأذرة. أضافة جلوتين الأذرة إلى السيمولينا في صناعة المكرونة يحسن من خواص الطبخ مثل نسبة الزيادة فى الحجم، بينما يقلل من نسبة الزيادة فى الوزن. وكذلك وجد أن زيادة إضافة جلوتين الأذرة حتى نسبة ٤٠% كانت مقبولة معنويا بالنسبة للتقييم التكنولوجي و الحسي. كما لوحظ أنه عند تخزين المكرونة المدعمة بالبروتين بإضافة جلوتين الأذرة على درجة حرارة الغرفة (٢٥م° ±١)، وجد عدم حدوث تغير فى التقييم الحسي حتى ١٥٠ يوم من التخزين. ومن هذا يمكن القول بأن استبدال السيمولينا بجلوتين الأذرة حتى نسبة٤٠% استبدال، تؤدى إلى تحسين التركيب الكيميائي، والخواص الطبيعية ، و التكنولوجية، والحسية، والمحتوى من العناصر المعدنية للمكرونة الناتجة من قمح الديورم (السيمولينا).

Table (6): Sensory evaluation of stored (at room temperature for 180 days) high protein macaroni prepared by replacing semolina with different levels of corn gluten meal.

Sensory properties	Replacing levels (%)						L.S.D.	Storage periods (days)							L.S.D
	0	10	20	30	40	50		0	30	60	90	120	150	180	
Appearance (20)	18.80[a] ±0.66	19.03[a] ±0.56	19.13[a] ±0.56	19.07[a] ±0.60	18.70[ab] ±0.43	18.40[b] ±0.43	0.57	19.58[a] ±0.40	19.38[a] ±0.40	19.06[a] ±0.30	18.84[ab] ±0.28	18.70[ab] ±0.18	18.44[ab] ±0.28	18.18[b] ±0.08	0.89
Color (20)	17.62[c] ±0.47	18.12[b] ±0.32	18.55[ab] ±0.37	18.98[a] ±0.41	18.22[b] ±0.45	17.24[c] ±0.45	0.44	18.72[a] ±0.63	18.62[a] ±0.63	18.42[ab] ±0.58	18.26[ab] ±0.63	18.04[ab] ±0.66	17.84[ab] ±0.66	17.64[b] ±0.66	0.82
Taste (20)	18.48[ab] ±0.89	18.64[ab] ±0.39	18.85[a] ±0.37	18.49[ab] ±0.51	18.02[b] ±0.45	17.55[c] ±0.37	0.46	18.78[a] ±0.50	18.68[a] ±0.50	18.54[ab] ±0.51	18.32[abc] ±0.52	18.08[abc] ±0.52	17.88[bc] ±0.52	17.66[c] ±0.50	0.66
Odor (20)	18.55[ab] ±0.91	18.78[a] ±0.41	18.98[a] ±0.41	18.60[ab] ±0.43	18.20[bc] ±0.43	18.00[c] ±0.43	0.46	19.08[a] ±0.73	18.92[a] ±0.41	18.72[ab] ±0.41	18.52[abc] ±0.41	18.32[bcd] ±0.41	18.12[cd] ±0.41	17.92[d] ±0.41	0.52
Stickiness (20)	18.98[a] ±0.69	19.07[a] ±0.39	18.77[a] ±0.48	18.68[a] ±0.45	17.98[b] ±0.41	17.45[c] ±0.45	0.47	18.94[a] ±0.65	18.82[a] ±0.65	18.26[ab] ±0.65	18.42[ab] ±0.65	18.22[ab] ±0.65	18.00[ab] ±0.68	17.74[b] ±0.65	0.85
Overall acceptability (100)	92.45[ab] ±1.96	93.65[ab] ±2.09	94.24[a] ±2.16	93.64[ab] ±2.40	91.14[b] ±2.18	88.65[c] ±2.14	2.40	95.10[a] ±2.39	94.44[ab] ±2.41	93.32[abc] ±2.25	92.36[abcd] ±2.36	91.30[bcd] 2.37±	90.28[cd] ±2.40	89.08[d] ±2.23	3.04

Each value is mean of ten replicates ± SD, means in the same row with different letters are significantly different at ($p \leq 0.05$).