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ENRICHING BALADY BREAD USING RED ALGAE (*Pterocladia capillacea*)

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ABSTRACT

This study aimed to use red algae *Pterocladia capillacea* as functional food. Red algae was incorporated in the formulations of balady bread at 2, 3 and 4 %. The effect of supplementation on chemical composition, minerals content, physical, chemical, and sensory properties of balady bread besides, rheological properties of wheat flour were studied. The protein, lipid, ash and fiber contents in red algae were 25.21, 2.28, 25.13 and 11.29%, respectively. Red algae was rich in all minerals compared to wheat flour. Only, phosphorous was higher in wheat flour than in red algae. Red algae was rich in the total essential amino acids. Rheological properties indicated that water absorption increased gradually from 54.2% for the control wheat flour dough to 62.2% for wheat flour dough supplemented with 4% red algae. Also, dough development time increased slightly for wheat flour supplemented with different levels of red algae. Balady bread supplemented with 4% red algae had the highest fiber and ash contents (2.33 and 2.20%, respectively). Supplementation of balady bread with tested red algae led to increasing the minerals content. Firmness values decreased by increasing red algae levels compared to the control balady bread. Organoleptic evaluation indicated that control balady bread and bread supplemented with 2% red algae exhibited good organoleptic properties score.

Key words: *Pterocladia capillacea, functional food, balady bread, physical and chemical properties.*

1.INTRODUCTION

Balady bread is one of the most important constituents of the Egyptian diet representing the main diet component for rich and poor Egyptian consumers. According to Danesi *et al.* (2010), algae powder can be added to improve the nutritional value of bread; it has high amounts of vitamins, microelements, especially the active biological materials. In macrobiotic diet, the intake of sea vegetables is 5% or less of the total daily amount of food (Kushi, 1986). The western diet recommended consuming about 29 g of algae weekly as a food supplement (about 4g/day) which is in agreement with the recent macrobiotic recommendations (Drum, 2003).

The red algae *Pterocladia capillacea*, contains a significant amount of soluble polysaccharides like agar, alginate and carrageenan which are widely used in the food industry as gelling or thickening agents in marmalade, ice creams, jellies, etc. (Plaza *et al.*, 2008). There is an interest in macro-algae hydrocolloids for human nutrition as they can act as dietary fiber, their physiological effects being closely related to their physicochemical properties such as solubility,viscosity, hydration, and ion-exchange capacities in the digestive tract. Red macro-algae in a source of bioactive compounds are helpful as antioxidant, antibacterial and antiviral activities (Lahaye and Kaeffer, 1997).

The available information on possible toxic properties or any other adverse effects of the red algae tested so far, stated that none of this algae showed any negative effect. All tests, including human studies, failed to reveal any evidence that would restrict the utilization of properly processed algal material (Chamorro, 1980).

The present study aimed to use the red algae (*Pterocladia capillacea*) as functional food supplementation, determine the acceptability level of supplementation algae powder in special balady bread for some categories and estimate the chemical and physical qualities of the bread product.

2. MATEREIALS AND METHODS

2.1. MATERIALS

Red macro algae *Pterocladia capillacea* was obtained from Alexandria shore by Edfina Company during May 2013. Wheat flour (82% extraction) was obtained from Boric El- Hagar stone mill, West Delta Flour Mills Company at Tanta City, El- Gharbia Governorate, Egypt.

2.2. METHODS

2.2.1.Preparation of red algae

Red algae was washed by fresh tap water to remove all mechanical impurities and water soluble substances, followed by air drying. Then, it was softened according to Imada and Takahshi (1986). In this method washed and dried algae was boiled under atmospheric pressure with 3% acetic acid solution for 10 minutes. The liquid phase drained, algae was washed and sun dried for 3 days. The dried samples were ground to fine powder and stored in low density polyethylene bags at room temperature (37 °C) for further uses.

2.2.2. Preparation of balady bread

Balady bread control was made with 100 **%** wheat flour (82% extraction), 1.5% activated compressed yeast, 1.5% sodium chloride and 75-80 ml water /100g flour according to Yasseen (1985). Algae were added to wheat flour at substitution levels of 2, 3 and 4%. The ingredients were mixed for 20 min by hand to form balady bread dough and left to ferment for 1h at 30 °C, then divided into 125 g/pieces. Each piece was molded on a wooden board previously covered with a fine layer of bran and left to ferment for 45 min at the same mentioned temperature. The fermented dough pieces were flattened to about 20 cm diameter, then baked at 400 ± 5 °C for 3- 5 min. by electric oven(UNOX, XBC605, Made in Italy). The loaves of bread were allowed to cool on racks for about 2 hrs before evaluation.

2.2.3. Chemical composition

The moisture, ether extract, total nitrogen, ash content, crude fiber contents were determined according to the methods described by A.O.A.C. (2000). Carbohydrate contents were calculated by difference. Energy value was calculated according to the method of Mahgoub (1999).

2.2.4. Minerals contents

Mineral contents of ash were determined using common methods described by A.O.A.C. (2000). Sodium and potassium were determined by flame photometry (Model 405 Corning, Halstead Essex, UK), while magnesium, calcium, zinc, manganese, iron, nickel, cadmium, lead and copper were determined using atomic absorption spectrophotometry (Perkin-Elmer, Model 403 Norwalk, Connecticut, USA). Phosphorus and iodine were determined calorimetrically (Spectronic 20 Gallenkamp, London, UK) .

2.2.5. Amino acids profile

Amino acids composition was determined according to the method described by Ozols (1990) using Beckman amino acid analyzer (Model 119 CL).

Amino acid score was calculated according to the method of FAO/WHO/UNU (2002) as follows**:**

Amino acid score

$$= \frac{\text{mg of amino acid in 1 g test protein}}{\text{mg of amino acid in requirement pattern}}$$

2.2.6. Rheological properties of bread dough

2.2.6.1. Farinograph and Extensograph parameters were determined using Brabender equipments as the methods described by A. A.C.C. (2000).

2.2.6.2. Falling number was determined according to the method described in A.A.C.C. (2000) and liquefaction number was calculated according to Finney (2001) as follow:

$$\text{Liquefaction Number} = \frac{6000}{\text{Falling number} - 50}$$

2.2.6.3. Falling time was calculated according to Kent-Jones and Amos (1967).

2.2.6.4. Determination of gluten

Wet, dry gluten and gluten index of wheat flour were determined using Glutomatic perten instruments (AB type2200 No. 005092, Huddling, Sweden) as described by Perten (1990).

2.2.7. Texture profile was determined as mentioned by Bourne (2002).

2.2.8. Sensory evaluation of balady bread

The organoleptic properties of balady bread samples were carried out according to El-Farra *et al.* (1982). Balady bread samples were subjected to sensory evaluation by ten members of Food Science and Technology Department, Faculty of Home Economics, Al-Azher Univ., Tanta. Each sample was sensorial evaluated for general appearance (15), crust color (15), crumb color (15), odor (15), taste (15), roundness (15), separation of layer (10) and overall acceptability (100).

2.2.9. Statistical Analysis

The statistical analysis was carried out using SPSS. Statistical software (version 11.0 SPSS inc., Chicago, USA), the results were expressed as means. Data were subjected to analysis of variance (ANOVA). The differences between means were tested for significance using Duncan's test at ($p \leq 0.05$) according to Armitage and Berry (1987).

3. RESULTS AND DISCUSSION

3.1. Chemical composition of tested wheat flour and red algae

Data in Table (1) recorded that, the highest contents of moisture, carbohydrate and energy were found in wheat flour. On the other hand, the highest contents of protein, lipid, ash and crude fiber were found in red algae.

These results were in agreement with those found by Khairy and El-Shafay (2013), who reported that the red algae *Pterocladia capillacea,* contained 23% protein, 37% ash,10% fiber and 28% carbohydrates**.**

Table (1) : Chemical composition of the tested wheat flour and red algae (as dryweight basis)

Components%	Wheat flour 82% extraction	Red algae *P. capillacea*
Moisture	**12.27**	**8.64**
Protein	**12.54**	**25.21**
Lipid	**1.83**	**2.28**
Ash	**1.30**	**25.13**
Crude fiber	**1.81**	**11.29**
Carbohydrates	**82.52**	**36.09**
Energy (kcal/100g)	**396.71**	**265.72**

3.2. Amino acid contents and amino acid scores of red algae

From Table (2), it could be noticed that *P. capillacea* is rich in total essential amino acids (36.84%). This value was higher than that given by the recommended pattern FAO/WHO (1991) for preschool children groups. These results are in agreement also with Kovac *et al.* (2013).

At the same time, isoleucine, leucine, lysine and valine were higher in red algae than those given by the recommended pattern (FAO/WHO, 1991) for preschool children group.

Also, the results presented in Table (2) showed that, methionine was the first limiting amino acid in red algae (0.20). Valine had the highest amino acid score among all the essential amino acids with value of 2.18 followed by isoleucine (1.76). These results are in agreement with Murata and Nakazoe (2001) who reported that the amino acid scores of the proteins of algae ranged from 60 % to 100% and these values were higher than that of the proteins of cereals and vegetables.

3.3. Mineral contents of tested wheat flour and red algae

Red algae were rich in all minerals compared to the tested wheat flour (Table 3). Only, phosphorous was higher in the tested wheat flour (171.41mg/100g) than in red algae 121mg/100g. Furthermore, mineral contents in red macro algae were higher than those in edible land plants and animal products (Rupérez, 2002). Creeksong (2003) reported that, the sea vegetables are effective in relatively small supplementary amounts and can supply our food with many missing elements.

Whitney and Rolfes (1996) mentioned that the basic component in macro algae is iodine, as essential trace element and integral part of two hormones released by the thyroid gland.

***Source of daily requirements of preschool children (Food and Nutrition Board, 2012)**

As shown in Table (3), iodine content was 23.7 mg/100g for red algae. The recommended daily dose for preschool children is 0.09 mg of iodine (Food and Nutrition Board, 2012). The intake of red algae per day would supply 0.948 mg of iodine.

Some heavy metals such as cadmium, nickel and lead were found to be 0.4, 34.78 and 0.304 mg/100g, respectively. This revealed that red algae in the present study can be considered as a safe product for consumption (Ortega-Calvo *et al.,* 1993).

3.4. Farinograph, Extensograph parameters and gluten quality of composite wheat flour with different levels of red algae

Water absorption increased gradually by increasing the replacement levels of red algae. It increased from 54.2% for the control to 62.2% for dough supplemented with 4% red algae as shown in Table (4).

B.U = Brabender unit

These results may be due to the high fiber content in red algae (11.29%)**.** This fact has been emphasized by dough weakening data with increasing of supplementation levels of red algae. Leon *et al.* (2000) mentioned that using of Kappa carrageenan (sulphated polysaccharide extracted from certain red algae) as a dough additive, has an ability to improve the specific volume of the bread due to its interactions with gluten proteins.

Table (2): Amino acid contents and amino acid scores of red algae.

Amino acids (g/100g protein)	*P.capillacea*	FAO/WHO for preschool children	Amino acid score
Histidine	1.38	1.9	0.73
Isoleucine	4.94	2.8	1.76
Leucine	7.58	6.6	1.15
Lysine	7.06	5.8	1.22
Methionine	0.50	2.5	0.20*
Phenylalanine	2.92	2.8	1.04
Tyrosine	2.43	3.5	0.69
Threonine	2.41	3.4	0.71
Valine	7.62	3.5	2.18
Total essential amino acids	36.84	32.8	

*First limiting amino acid

Table(3): Mineral contents in wheat flour and red algae compared with the recommended daily dose for preschool children.

Minerals (mg/100g)	Wheat flour	*P. capillacea*	*Daily requirement (mg) for preschool 1-3 y	*P.capillacea* Intake(mg) (4%substitute)
Major minerals				
Calcium	26.21	743	700	29.72
Phosphorous	170.41	121	460	4.84
Sodium	34.76	2200	1005	88.0
Potassium	116.38	1764	3000	70.56
Magnesium	---	230	80	9.2
Trace minerals				
Iron	2.05	100	7	4.0
Zinc		70	3	2.8
Copper		3.20	0.34	0.128
Iodine		23. 70	0.09	0.948
Manganese		10.50	1.2	0.42
Heavy metals				
Cadmium		0.40		
Nickel		34.78		
Lead		0.304		

Table(4): Farinograph, Extensograph parameters and gluten quality of tested wheat flour supplemented with different levels of red algae.

Parameter	Control	Red algae supplementation level, %		
		2	3	4
Farinograph data				
Water absorption (%)	54.2	60.0	61.5	62.2
Arrival time (min)	0.5	0.5	0.5	0.5
Dough development (min)	1.0	2.0	1.5	1.5
Dough stability (min)	9.5	7.0	5.5	5.0
Dough weakening (B.U)	80	100	110	120
Extensograph data				
Elasticity (B.U)	260	210	160	140
Extensibility (mm)	150	145	125	120
Proportional number (P.N)	1.73	1.45	1.28	1.16
Energy (cm^2)	26	25	25	23
Gluten quality				
Wet gluten, %	32.21	28.01	27.91	20.83
Dry gluten, %	11.01	9.79	9.14	7.75
Gluten index, %	83.96	78.32	77.47	76.39

Similar results were observed by Rosell *et al.* (2001) who reported that the differences in water absorption are mainly caused by the great number of hydroxyl groups which exist in the fiber structure and allow more water interactions through hydrogen bonding.

The dough development time in both the control dough and the dough supplemented with different levels of red algae increased slightly. Dough stability was higher in the control sample (9.5min)than other dough samples supplemented with different levels of red algae. Rosell *et al.*(2001) reported that stability of wheat flour dough is an indicator of the flour strength and the higher values point to stronger dough. Similar results were reported by Sudha *et al.* (2007).

The results in Table (4) showed that wheat flour supplemented with red algae at different levels minimized the extensibility. This decrement might be due to the deficiency of gliadin and glutenin in algae powders. These results are in line with those reported by Hafez (1996).

The proportional number (P.N) (ratio between dough elasticity and dough extensibility) decreased with increasing the levels of red algae from 1.73 for the control to 1.16 for samples supplemented with 4% red algae. Energy ranged between 26 cm^2 for the control and 23 cm^2 for dough supplemented with 4% red algae. These results are in agreement with those obtained by Jones and Erlander (1967).

The highest wet gluten was presented in the control (32.21%), while the lowest value was found in wheat flour supplemented with 4% red algae (20.83 %). So that, gluten content was decreased by increasing the levels of red algae, the results appropriate to the absence of glutenin and gliadin in algae. The obtained results agree with those reported by Hassan *et al.* (2011).

From the results presented in Table (4), it could be also noticed that the control had the highest gluten index (83.96%), while wheat flour supplemented with 4% red algae had the least value of gluten index (76.39%).

3.5. Falling number of wheat flour samples supplemented with different levels of red algae.

Addition of different levels of red algae to wheat flour increased the falling number value and falling time compared with the control sample (Table 5). Falling number was 270 sec for the control sample, while it was 288 sec for wheat flour supplemented with 4% red algae.

Table (5): Falling number of wheat flour supplemented with different levels of red algae.

Parameter	Control	Red algae supplementation level, %		
		2	3	4
Falling number, sec	**270**	**272**	**286**	**288**
Falling time, sec	**210**	**212**	**226**	**228**
Liquefaction number, %	**27.27**	**27.03**	**25.42**	**25.21**

On the other hand, the liquefaction number was decreased by increasing supplementation ratios with red algae. This means that, addition of different levels from red algae decreased the alpha-amylase in wheat flour by substitute red algae in samples.

3.6. Chemical composition of balady bread samples

There were significant differences ($P \leq 0.05$) between the control balady bread samples and other samples supplemented with different levels of red algae for all constituents (Table 6). Moisture content increased by increasing of red algae supplementation levels. It may be due to hydrocolloids in algae. These results were in agreement with Gray and Bemiller (2003) who reported that hydrocolloids were added to bakery products to extend their shelf-life by keeping the moisture content and retarding the staling during storage. Selomulyo and Zhou,(2007) reported that the presence of this hydrocolloid increased the moisture content in the final bread.

No significant differences were observed in the total lipid content between supplemented balady bread samples. Protein, fiber and ash contents were increased gradually by increasing the levels of red algae. The protein, fiber and ash contents of balady bread samples ranged from 10.54, 1.82 and 1.68% for the control to 11.19, 2.33 and 2.2% for bread supplemented with 4%red algae, respectively. This could be attributed to high content of protein, fiber and ash content of the added red algae (Table 1). Nguyen (2014) found that protein, lipid, carbohydrates, calcium, iron, phosphore and energy of bread prepared with 3% spirulina were, 11.0%, 5.7%, 54.2 %, 90.0 mg/100gm, 2.7 mg/100gm, 125.0 mg/100gm and 312.1 Kcal/100gm, respectively .

According to Becker (2007) cereal such as wheat flour is low in protein content, but algae are considered a source of protein. Hence the consumption of balady bread supplemented with algae means eating bread with higher protein content and improved protein quality. Total carbohydrate contents of balady bread samples supplemented with different levels of red algae were significantly lower than the control sample.

Means of energy values ranged between 389.88 kcal/100g for balady bread supplemented with 4 % red algae and 393.05 kcal/100g for the control.

3.7.Mineral contents of balady bread samples

Data in Table (7) illustrated that, calcium content in the control balady bread was 38.70 mg/100g. Supplemented balady bread with tested red algae led to an increase in calcium content. The increment percentages of Ca were 128.10% when wheat flour was replaced with 4% red algae. So that the addition of red algae to balady bread appeared more effective in increasing Ca content (Devi *et al*., 2011). On the other hand, control sample had the lowest Ca ,P, Fe and K content when compared with balady bread supplementation with different levels of red algae. The highest K content (297.48 mg/100g) was recorded for balady bread supplemented with 4% red algae.

3.8. Texture profile of balady bread samples

From Table (8), it could be observed that firmness values were decreased by increasing of red algae levels compared to the control balady bread. It may be due to the increase in protein and fiber contents by the addition of red algae. Hydrocolloids when used in small quantities (<1%w/w in flour) are expected to increase water retention and decrease firmness and starch retrogradition (Collar *et al.,* 1999).

These results are in contrast with those obtained by Sangnark and Noomhorn (2004) who found that high protein and fiber ingredients added into bread formulation increased the hardness of bread. Thus, the red algae used in the present study caused differences on firmness parameter of balady bread samples.

Table (6): Chemical composition of balady bread supplemented with different levels of red algae.

Components (%)	Control	Red algae supplementation level, %		
		2	3	4
Moisture	**34.14[c]**	**34.47[b]**	**34.53[a]**	**34.54[a]**
Protein	**10.54[d]**	**10.78[c]**	**11.03[b]**	**11.19[a]**
Lipid	**1.41[b]**	**1.55[a]**	**1.58[a]**	**1.60[a]**
Fiber	**1.82[c]**	**2.17[b]**	**2.27[a]**	**2.33[a]**
Ash	**1.68[d]**	**1.94[c]**	**2.07[b]**	**2.20[a]**
Carbohydrates	**84.55[a]**	**83.56[b]**	**83.05[c]**	**82.68[d]**
Energy(Kcal/100gm)	**393.05[a]**	**391.31[b]**	**390.54[c]**	**389.88[d]**

In a row, means having the same superscript letters are not significantly different at 5 % level.

Table (7): Mineral contents of balady bread supplemented with different levels of red algae.

Treatments	Minerals, mg/100g				
	Ca	K	P		Fe
Control	**38.70**	**237.02**	**264.64**		**2.59**
Red algae levels, %					
2	**58.25**	**260.11**	**276.54**		**2.68**
3	**78.03**	**284.64**	**292.30**		**2.80**
4	**88.27**	**297.48**	**311.37**		**2.91**

Table (8):Texture profile of balady bread supplemented with different levels of red algae.

Texture profile	Control	Red algae supplementation level, %		
		2	3	4
Firmness (N)	**6.860**	**5.980**	**4.950**	**4.780**
Cohesiveness	**0.541**	**0.555**	**0.594**	**0.607**
Gumminess (N)	**3.807**	**2.954**	**2.527**	**2.137**
Chewiness (Nm)	**2.455**	**1.751**	**1.485**	**1.203**
Springiness (mm)	**0.645**	**0.593**	**0.588**	**0.563**
Resilience	**0.389**	**0.379**	**0.378**	**0.342**

The internal resistance of bread crumb is evaluated by cohesiveness. The results presented in Table (8) showed that, cohesiveness values for balady bread samples supplemented with red algae were higher than those of control sample. The highest cohesiveness value (0.607) was found for balady bread supplemented with 4% red algae.

From the same results, it could be observed that chewiness values of the bread generally followed a similar trend of firmness. Chewiness is one of the texture parameters easily correlated with sensory analyses through the panels (Gomez *et al.*, 2007). The least chewiness value (1.203 Nm) was recorded for balady bread supplemented with 4% red algae.

Springiness values of all treatments were decreased as the addition of red algae increased. The lowest springiness value (0.563) was recorded by balady bread supplemented with 4% red algae.

Resilience values were slightly higher in the control balady bread than in balady bread supplemented with different levels of red algae. Resilience values were low fights to regain its original position in balady bread supplemented with different levels of red algae than the control.

3.9. Organoleptic properties of balady bread samples

Organoleptic properties of balady bread supplemented with red algae at different levels are shown in Table (9).There were no significant differences between the control balady bread

Table (9): Organoleptic properties of balady bread supplemented with different levels of red algae

Parameter	Control	Red algae supplementation level, %		
		2	3	4
General appearance (15)	14.33±0.7[a]	14.55±0.5[a]	14.22±0.4[a]	13.11±0.6[b]
Crust color (15)	14.55±0.3[b]	14.83±0.2 [a]	14.61±0.2[ab]	14.16±0.3[c]
Crumb color (15)	14.70±0.2[a]	13.30±0.3[b]	13.07±0.05[c]	12.64±0.1[d]
Roundness(15)	14.55±0.4[a]	14.72±0.3 [a]	14.55±0.1[a]	14.44±0.3[a]
Taste (15)	14.55±0.5[a]	14.38±0.6 [a]	13.88±0.3[b]	13.11±0.7[c]
Odor (15)	14.72±0.3[a]	13.77±0.3 [b]	13.53±0.2[b]	13.15±0.1[c]
Separation of layer (10)	9.44±0.5[a]	8.05±0.7 [b]	7.93±0.05[b]	7.62±0.2[b]
Overall acceptability (100)	96.84[a]	93.60[b]	91.79[c]	81.37[d]

In a row, means having the same superscript letters are not significantly different at 5 % level.

sample and balady bread supplemented with 2 and 3% red algae for most of the evaluated characteristics. The mean of general appearance value was the highest in balady bread supplemented with 2% red algae (14.55).

From the statistical analysis of sensory evaluation, it could be observed that, there were no significant differences in crust color between control balady bread and other samples supplemented with 2, and 3 % red algae. The results showed that balady bread supplemented with 2% red algae had the highest scores.

About crumb color, there were significant differences between samples. However, the control sample showed the highest mean score (14.70). There were no significant differences ($p \leq 0.05$) for roundness between control sample and other balady bread samples supplemented with different levels of red algae. Also, no significant differences ($p \leq 0.05$) were recorded for taste scores between control and balady bread supplemented with 2% red algae. Balady bread samples with 4% red algae had the lowest taste score (13.11). These effects may be related to the increase of fiber content of the red algae which affected taste of bread (Hussein *et al*., 2013).

The highest mean values of odor, separation layer and overall acceptability were recorded for control balady bread followed by balady bread supplemented with 2% red algae. From the same results, it could be observed that, the control sample and balady bread supplemented with 2% red algae, exhibited good organoleptic properties scores. While, the balady bread supplemented with 3% red algae become in the second degree.

Nguyen (2014) mentioned that the sensory evaluation of bread supplemented with 1,2 and 3% Spiraling caused a decrease in color , aroma and taste .

From the above results it could be recommended that the addition of *P. capillacea* to wheat flour up to 2% will give bread without changing in its organoleptic properties.

These results showed that, red algae are important sources for protein, fiber, ash and total soluble carbohydrates. Edible red algae could be used as a food supplement to meet the recommended daily preschool children intakes of some macro minerals and trace elements.

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إثراء القيمة الغذائية للخبز باستخدام الطحالب الحمراء

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ملخص

استخدمت الطحالب الحمراء كغذاء وظيفى فى الخبز البلدى بنسبة 2و3و4 %. تم دراسة تأثير التدعيم على التركيب الكيماوى ومحتوى المعادن والصفات الفيزيائية والكميائية والحسية للخبز البلدى بالاضافة الى الخصائص الريولوجية لعينات الدقيق . قد وجد ان محتوى البروتين والدهون والرماد والالياف فى الطحالب الحمراء 25.2 و 2.28 و 25.13 و 11.29% على التوالى . ويظهر جليا ان الطحالب الحمراء غنية فى جميع الاملاح المعدنية مقارنة بدقيق القمح، أما دقيق القمح كان الأعلى فى الفوسفور فقط عن الطحالب الحمراء. والطحالب الحمراء غنية فى الاحماض الامينية الأساسية. و تشير الخصائص الريولوجية الى زيادة امتصاص الماء تدريجيا من 54.2 للعينة القياسية الى 62.2 لعينة دقيق القمح المدعم بـ 4% طحالب حمراء . زاد زمن تكون العجينة تدريجيا لدقيق القمح المدعم بمستويات مختلفة من الطحالب الحمراء. كان الخبز البلدى المدعم بـ 4% طحالب حمراء أعلى فى البروتين والدهن والالياف ومحتوى الرماد (11.19و 1.6و 2.33و 2.20% على التوالى).

وقد وجد ان تدعيم الخبز البلدى بعينة الطحالب الحمراء بنسبة 4% ادت الى زيادة محتوى الاملاح المعدنية. واعلى وزن للرغيف وجد فى عينة الخبز المدعم بنسبة 4% طحالب حمراء، بينما كانت الاستدارة متماثلة فى كل العينات. وتناقصت قيم الصلابة تدريجيا بزيادة مستوى الطحالب الحمراء مقارنة بعينة الخبز البلدى القياسية. اشارت قيم التقييم الحسى الى ان عينة الخبز البلدى القياسية والمدعمة بنسبة 2% طحالب حمراء كانت جيدة فى الصفات الحسية.

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