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EFFECT OF GERMINATION AND PRESSURE COOKING ON THE CHEMICAL COMPOSITION AND ANTINUTRITIONAL FACTORS OF THE NAKED BARLEY FLOUR

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ABSTRACT

Barley (*Hordeum vulgare* L.) is an ancient and important cereal grain crop. It has been an important food source in many parts of the world. This study was carried out to investigate the effect of germination and pressure cooking on the chemical composition and various antinutritional factors (Phytic acid, tannins and trypsin inhibitor activities) of the barley cultivar Giza 131. Processing treatments showed significant effect on protein, amino acids, fat, mineral, fiber and antinutritional factors contents of barley. Germination increased the protein, fiber and calcium content to 9.86%, 1.58% and 75.89 mg/100g, respectively. Also, all essential amino acid contents were increased by germination. In contrast protein, fiber and calcium showed decrease by pressure cooking to 8.56%, 1.24% and 54.12 mg/100g, respectively. In germination and pressure cooking of barley fat, ash, P, Fe, and Zn content were decreased. Pressure cooking showed maximum decrease of antinutritional factors (Phytic acid, tannins and trypsin inhibitor activities). Maximum reduction was observed in trypsin inhibitor (61.4%), followed by phytic acid (51.2%) compared with raw barley.

Key words: Barley, germination, pressure cooking, antinutritional factors.

INTRODUCTION

Historically, barley (*Hordeum vulgare* L.) is an important food source in many parts of the world, including the Middle East, North Africa, Northern and Eastern Europe (Iran, Morocco, Ethiopia, Finland, England, Denmark, Russia and Poland), and in Asia (Japan, India, Tibet and Korea) (Newman and Newman, 2006).

Barley is the fourth most produced cereal in the world after wheat, maize and rice. It is mainly used as animal feed, but there is a growing interest for human food. In most European countries, wheat and barley are the most common used cereal grains in poultry and pig feeding (Bergh *et al*., 1999).

Barley flour prepared from pearled grain through hammer milling or roller milling, can easily be incorporated into wheat based products, including bread, cakes, cookies, noodles and extruded snack foods (Newman and Newman, 1991).

Unfortunately, very little barley is utilized as human food because of its hulled nature, difficulties in milling and lack of gluten proteins. Among cereals, barley has one of the highest levels (up to 6%) of β-glucan, a water soluble polysaccharide that is a linear chain of the β-glucopyransoyl unit; about 70% are linked (1 → 4) and about 30% (1 → 3) (Lazaridou *et a.l,* 2003).

Barley foods are healthful when added to the diet. Barley whole grain ingredients are low fat, and high in fiber, which make them ideal choices for individuals. Their beta-glucan soluble fiber content confers barley products with cholesterol-lowering properties similar to oats. Emerging data also suggest benefits beyond cholesterol reduction, including lowered postprandial blood glucose, and an increased feeling of satiety following barley consumption

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(United States Department of Health and Human Services and United States Department of Agriculture, 2005).

U.S. Food and Drug Administration allowed whole grain barley and barley containing products to carry a health and recommended that, 3g daily intake of β–glucan reduces the risk of coronary heart diseases by lowering blood cholesterol. Considering the health benefits of barley β–glucan, the human consumption of barley should be encouraged (FDA, 2005).

Anti-nutritional factors are compounds which reduce the nutrient utilization and/or food intake of plants or plant products used as human foods and they play a vital role in determining the use of plants for humans (Habtamu *et al.,* 2014).

Different authors have reported that soaking, cooking, toasting, autoclaving, microwave cooking, pressure cooking, extrusion cooking, germination and chemical treatment improve the quality of seeds because of the removal or inactivation of some anti-nutritional factors in many instances, usage of only one method may not effect the desired removal of anti-nutritional substances and a combination of two or more methods may be required. Wet processing including soaking, germination and fermentation leads to a reduction in phytic acid and increases of the minerals solubility in foods and could thus improve bioavailability of minerals in cereals and legumes (Afify *et al.*, 2011). The most effective treatments are fermentation and germination (El Maki *et al.*, 2007; Elkhalifa and Bernhardt, 2010; Liang *et al.*, 2008).

The aim of this work was to investigate the effect of germination and pressure cooking on the chemical composition and various antinutritional factors (phytic acid, tannins and trypsin inhibitor activities) of the hulless barley (Giza 131 cultivar).

MATERIALS AND METHODS

Barley (Giza 131 cultivar-naked barley) was obtained from the Agriculture Research Center, Ministry of Agriculture, Giza, Egypt. The raw seeds were purified from impurities, washed, soaked in distilled water overnight. The soaked seeds divided into two portion, the first portion was allowed to germinate for two days at room temperature. The second portion was cooked in a pressure cooker for 7 minutes. The germinated and cooked cereals were dried in forced hot air drier at 40°C for 48 hours. The dried seeds were milled with laboratory mill and compared with raw barley (Fig. 1).

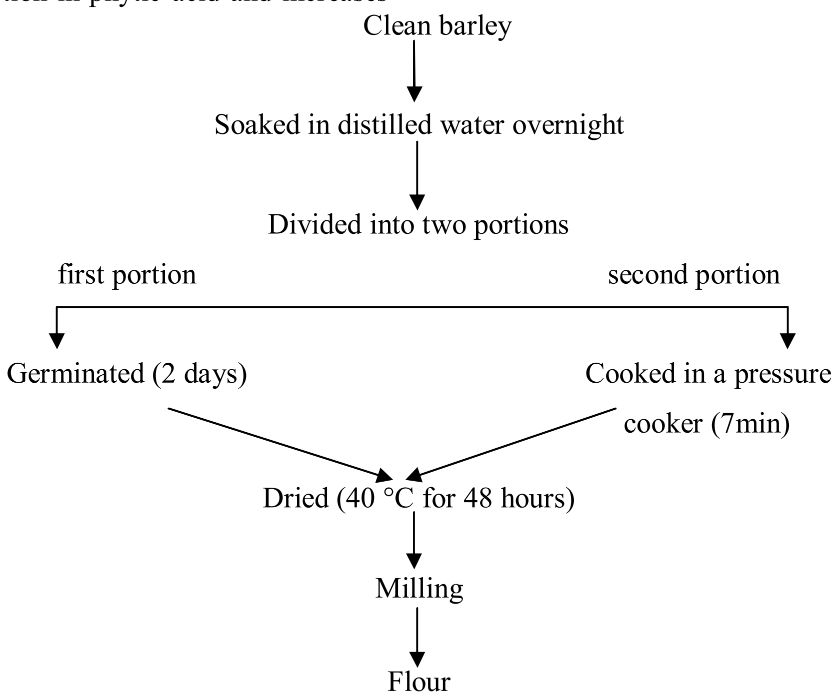

Fig. 1. Preparation of barley flour

Determination of Gross Chemical Composition

Moisture, protein, fat, crude fiber and ash contents were determined according to the methods described in the AOAC (2005). Total carbohydrate was calculated by difference TS-(fat + protein + ash) according to Guzman *et al.* (1999).

Determination of Mineral Contents

To extract P, Ca, Zn and Fe, samples were dried and ashed at 550-600ºC, then the ash was dissolved in hydrochloric acid according to Jackson (1973). Determination of phosphorus was carried out according to the procedure for phosphorus analysis by the sulphomolybdo-phosphate blue colometric method according to Tsai *et al*. (1975). Calcium, Iron and Zinc were determined by atomic absorption spectrophotometry (AOAC, 1990).

Determination of amino acids

Amino acids were determined by using amino acid analyzer according to Becker *et al.* (1981). The essential amino acids were calculated as per cent of 100g protein.

Determination of anti-nutritional compounds

Trypsin inhibitor activity (TIA)

Trypsin inhibitor activity was assayed by the method of Hamerstand *et al.,* (1981).

Tannins content

Tannins were determined using vanillin hydrochloric acid (V. HCl) method as described by Price and Butler (1977).

Phytate content

Phytate contents were determined by an anion exchange chromatography method (AOAC, 1997).

Statistical Analysis

Experiment was carried out in triplicate and the data were transferred to the SPSS (2007) version 16 program, data was statistically analyzed by using one way ANOVA

RESULTS AND DISCUSSION

Gross Chemical Composition of Barley

Gross chemical composition of raw and treated barley, is illustrated in Fig. 2. Results revels that the protein content of raw barley (8.70%) increased to 9.86% on germination. In contrast, it was decrease to 8.56% after pressure cooking. Dagnia *et al.,* (1992) reported that, the increase in protein content with germination treatment could be attributed to the utilization of fats and carbohydrates as energy sources for the developing sprouts. Kamal *et al*. (2013) found that the content of protein of raw and germinated barley ranged between 8.75-13.05%.

In germination and pressure cooking of barley, fat and ash percentages were decreased compared to raw barley. Kamal *et al*. (2013) reported that germinated barley showed rather slight decrease in crude fat content. The decrease of crude fat may be due to the increase activity of lipases during soaking and germination (Kylen and Mc Cready, 1975).

The decrease of ash content may be due to the transfer of some elements from seeds to surrounding aqueous medium (Tabekhia and Luh, 1980).

Crude fiber content increased in barley by germination, while it decreased by pressure cooking (Fig. 2). These results agree with those reported by Kamal *et al*., (2013). Chung *et al*., (1998) reported that in barley sprouting was associated with significant increase in crude fiber from 3.75% in unsprouted barley to 6% in 5 days sprouts due to synthesis of structural carbohydrates such as cellulose and hemicellulose, a major constituent of cell walls.

Results in Table 1 reveal increment in calcium by germination treatment, while phosphorus, iron and zinc were decreased. The same Table indicated that pressure cooking of barley showed decreased of Ca, P, Fe and Zn. This observation is supported by Kamal *et al*. (2013), who found that germination barley decreased Fe and Zn and increase Ca. Processing techniques such as soaking, cooking, germination and fermentation of white sorghum decreased each of P, Fe and Zn contents (Abd El-Moneim *et al.,* 2012). Reduction of P, Fe and Zn contents after soaking may be attributed to leaching each of Fe and Zn ions into the soaking medium (Saharan *et al.,* 2001).

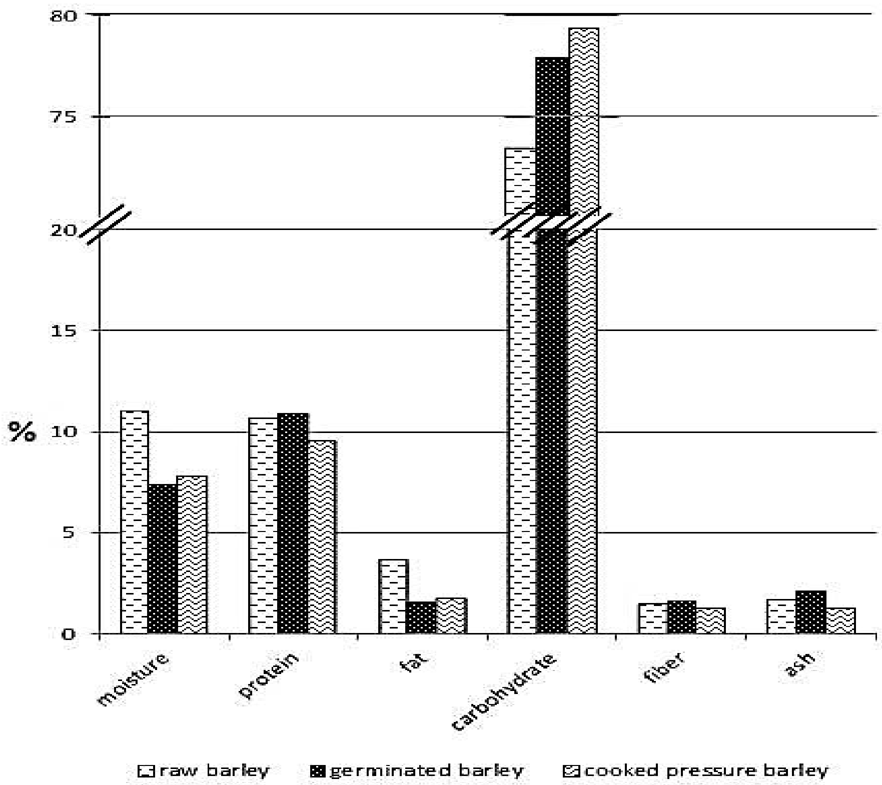

Fig. 2. Chemical composition of barley

Table 1. Mineral composition of raw, germinated, and cooked barley (mg/100g)

Treatments	Macro elements		Micro elements	
	Ca	P	Fe	Zn
Raw barley	68.35	567	5.88	3.05
Germinated barley	75.89	542	5.11	2.75
Cooked pressure barley	54.12	358	4.98	2.15

Essential Amino Acid Contents of Barley

Germination is a biotechnological process in which metabolic enzymes, such as proteinases are activated and thereby, release some amino acids and peptides. This may use to synthesis and utilization to form new proteins. Consequently the nutritional quality of proteins is enhanced. Thus germination has been identified as a simple technological procedure for improving the nutritional quality of legumes and cereals (Khattak *et al.*, 2008).

Amino acid contents (g/100g protein) of raw and treated barley flour were determined and the obtained results are presented in Table 2. It is observed that there was an increase of all essential amino acid contents induced by germination. It is noticed that germinated barley flour had higher quantity of all essential amino acids compared with cooked barley flour. The essential amino acids content in the products was found to meet the essential amino acids profile of the FAO/WHO reference protein for 0.5-1years children (FAO/WHO, 2002). These

Table 2. Essential amino acid contents of barley (g/100g protein)

Amino acid	Barley (Giza 131)			*FAO/WHO
	Raw	Germinated	Cooked pressure	0.5-1 yr
Isoleusein	3.59	3.75	3.22	3.2
Leusein	6.95	6.98	5.63	6.6
Lysine	2.97	2.98	2.66	5.7
Methionine + Cystine	4.22	4.36	4.08	2.8
Phenylalanine +Tyrosine	7.37	7.67	6.36	5.2
Valine	4.16	4.21	4.11	4.3
Histidine	2.73	2.89	2.77	2
Threonine	3.05	3.12	2.98	3.1

*FAO/WHO (2002). Energy and protein requirements, report of a joint, FAO/ WHO/ UNU expert consultation technical report, Series No. 724, Geneva

results are in agreement with Kamal *et al.* (2013), who showed that the germination of barley showed an increase of the essential amino acid contents. The increase in the amino acids by germination might be due to an increase in proteolytic activity during sprouting desirable for nutritional improvement of cereals because it leads to hydrolysis of prolamins and the liberated amino acids such as glutamic and proline which converted to limiting amino acids such as lysine (Chavan and Kadam, 1989). Also, it was suggested that heat processing could dissociate the structure of carbohydrate-protein interaction products, thus making protealysis easier (Scathe and Salunkhe, 1981).

Anti-nutritional Factors of Barley

The obtained data in Table 3 revealed that phytic acid, tannins and trypsin inhibitor contents were reduced after germination and after pressure cooking. Pressure cooking resulted in maximum reduction of all type of antinutritional factors. These results agree with Ko¨ksel *et al.,* (1999) who reported that barley bulgur had significantly lower levels of phytate by pressure cooking. Hussain *et al.* (2011) and Abd El-Moneim *et al.,* (2012) reported that processing techniques such as soaking, cooking, germination and fermentation of white sorghum, wheat and mungbean reduced the levels of antinutritional factors, which including phytates, phenols, tannins and enzyme inhibitors.

The breakdown of phytic acid during germination could be due to increase the activity of endogenous phytase for its use as source of inorganic phosphate during germination (Megat and Azrina, 2012).

The reduction of trypsin inhibitor by soaking treatment may be due to the water soluble nature of inhibitor that permits its migration from barley seeds into the soaking medium (Abd El-Hady and Habiba, 2002).

In conclusion, germination and cooking pressure treatments improve the quality of barely flour because of the removal or inactivation of some anti-nutritional factors.

Table 3. Phytic acid, tannins and trypsin inhibitor of barley

Treatment	Phytic acid (%)	Reduction (%)	Tannins (mg/g)	Reduction (%)	Trypsin inhibitor (U/mg)	Reduction (%)
Raw barley	2.5±0.28	-	12.39±0.45	-	5.44±0.33	-
Germinated barley	2.07±0.21	17.20	10.82±0.23	12.67	3.39±0.29	37.68
Cooked pressure barley	1.22±0.02	51.20	6.97±0.19	43.74	2.10±0.23	61.4

Data presented as means ± standard deviation (N = 3). Means are significantly different ($p < 0.05$).

REFERENCES

Abd El-Hady, A. and R.A. Habiba (2002). Effete of soaking and extrusion conditions on antinutrients and protein digestability of legume seeds, Lebensm. Wiss. U. Technol., 36: 285-293.

Abd El-Moneim, M.R., H.S. El-Beltagli, S.M. Abd El-Salam and A.A. Omran (2012). Effect of soaking, cooking, germination and fermentation processing on proximate analysis and mineral content of three white sorghum varieties (*sorghum bicolor* L. moench). Not. Bot. Horti. Agrobo., 40 (2): 92-98.

Afify, A.M.R., H.S. El-Beltagi, S.M. Abd El-Salam and A.A. Omran (2011). Bioavailability of iron, zinc, phytate and phytase activity during soaking and germination of white sorghum varieties. PLoS ONE, 6 (10): 25512, 1-7.

AOAC (1990). Association of Official Analytical Chemists. Official Methods of Analysis 15th Ed. AOAC, Washington DC.

AOAC (1997). Official Methods of Analysis (16th Ed.). Association of Official Analytical Chemists, Washington, DC.

AOAC (2005). Official Methods of Analysis of Association of Official Analytical Chemists. 18th Ed. Gaithersburg, Maryland, USA, AOAC Int.

Becker, R., E.L. Wheeler, K. Lorenz, A.F. Stafford, O.K. Grosjean, A.A. Bschart and R.M. Saunders (1981). A composition study amaranth grain. J. Food Sci., 46 : 1175-1180.

Bergh, M.O., A. Razdan and P. Aman (1999). Nutritional influence of broiler chicken diets based on covered normal, waxy and high amylose barleys with or without enzyme supplementation. Anim. Feed Sci. and Technol., 78 : 215-226.

Chavan, J.K. and S.S. Kadam (1989). Nutritional improvement of cereals by fermentation. Crit. Rev. Food Sci. Nut., 28: 349 – 400.

Chung, T.Y., E.N. Nwokolo and J.S. Sim (1998). Compositional and digestibility changes in sprouted barley and canola seeds. Plant Foods Hum. Nut., 39 (3): 267-278.

Dagnia, S.G., D.S. Petterson, R.R. Bell and F.V. Flanagan (1992). Germination alters the chemical composition and protein quality of lupin seeds. J. Sci. Food Agric., 60: 419-423.

El Maki, H.B., S.M. Abdel Rahaman, W.H. Idris, A.B. Hassan, E.E. Babiker and A.H. El-Tinay (2007). Content of antinutritional factors and HCl-extractabitity of minerals from white bean (*Phaseolus vulgaris*) cultivars: Influence of soaking and/or cooking. Food Chem., 100 : 362-368.

Elkhalifa, A.O. and R. Bernhardt (2010). Influence of grain germination on functional properties of sorghum flour. Food Chem., 121: 387-392.

FAO/WHO (2002). Energy and protein requirements, report of a joint, FAO/ WHO/ UNU expert consultation technical report, Series No. 724, Geneva.

FDA (2005). FDA allows barley products to claim reduction in risk of coronary heart disease, FDA News. Online at: http:// www fda.gov/bbs/tropics/news/NEWO 1287. html.

Guzman, G.M., F. Morais, M. Ramos and L. Amigo (1999). Influence of skimmed milk concentrate replacement by dry dairy products in a low fat set-type yoghurt mode system. J. Food Sci. and Agric., 79 (8): 1117-1112.

Habtamu, F., F. Gemede and N. Ratta (2014). Antinutritional factors in plant foods: Potential health benefits and adverse effects. Int. J. Nutr. and Food Sci., 3 (4): 284-289.

Hamerstand, G.F., L.T. Black and J.D. Glover (1981). Trypsin inhibitors in soy products: Modification of the standard analytical procedure, Cereal Chem., 58 (1): 42-45.

Hussain, I., M.B. Uddin and M.G. Aziz (2011). Optimization of antinutritional factors from germinated wheat and mungbean by response surface methodology. Int. Food Res. J., 18 (3): 957-963.

Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi.

Kamal, E.Y., F. El-Fishawy, S. Ramadan and A. Abd El-Rahman (2013). Nutritional assessment of barley, talbina and their germinated products. Frontiers in Sci., 3 (2): 56-65.

Khattak, A.B., A. Zeb and N. Bibi (2008). Impact of germination time and type of illumination on caroteinoid content, protein solubility and in-vitro protein digestibility of chickpea (*Cicer arietinum* L.) sprouts. Food Chem., 109: 797-801.

Ko¨ksel, H., M.J. Edney and B. Ozkaya (1999). Barley Bulgur: Effect of processing and cooking on chemical composition. J. Cereal Sci., 29: 185–190.

Kylen, A. M and R. M. Mc Cready (1975). Nutrients in seeds and sprouts of alfalfa, lentils, mungbean and soybeans. J. Food Sci., 40: 1008-1009.

Lazaridou, A., C.G. Biliaderis and M.S. Izydorczyk (2003). Molecular size effects on rheological properties of oat β-glucans in solutions and gels. Food Hydrocolloids, 17: 693–712.

Liang, J., B.Z. Han, M.J.R. Nout and R.J. Hamer (2008). Effects of soaking, germination and fermentation on phytic acid, total and *in vitro* soluble zinc in brown rice. Food Chem., 110: 821- 828.

Megat, M.R. and A. Azrina (2012). Effect of germination on total phenolic, tannin and phytic acid contents in soybean and peanut. Int. Food Res. J., 19 (2): 673-677.

Newman, C.W. and R.K. Newman (2006). A brief history of barley foods. Cereal Foods World, 51: 4–7.

Newman, R.K. and C.W. Newman (1991). Barley as a food grain. Cereal Foods World, 36: 800-805.

Price, M.L. and L.G. Butler (1977). Rapid visual estimation and spectrophotometer determination of tannin content of sorghum grain. J. Agric. and Food Chem., 25:1268-1273.

Saharan, K., N. Khetarpaul and S. Bishnoi (2001). HCl-extractability of minerals from rice bean and faba bean: Influence of domestic processing methods. Innovative Food Sci., Emerging Technol., 2 (4): 323-325.

Scathe, S.K. and D.K. Salunkhe (1981).Studies on Trypsin and chymotrypsin inhibitory activities, hemagylutinating activity and sugars in the great Northen bean (*Phaseolus vulgaris* L), J. Food Sci., 46 (5): 626-630.

Spss Inc. (2007). Spss for windows. Release 16.0 .Spss Inc. Chicago, IL.USA.

Tabekhia, M.M. and B.S. Luh (1980). Effect of germination, cooking and canning on phosphorus and phytate retention in dry beans. J. Food Sci., 45: 406-408.

Tsai, C.Y., A. Dalby and R.A. Jones (1975). Lysine and tryptophan increased during germination of maize seed. Cereal Chem., 52 : 356.

United States Department of Health and Human Services and United States Department of Agriculture (2005). Dietary Guidelines for Americans 2005.Washington, DC. http:// www. health.gov/ Dietary guidelines /dga 2005/document/pdf/DGA2005.pdf.

تأثير الإنبات والطبخ تحت تأثير الضغط على التركيب الكيميائي وبعض مضادات التغذية لدقيق الشعير العاري

حنان السيد محمد - على عبدالرحمن عبدالجليل – مديحة عبدالجواد الشيوي – محمد مجدى العباسي

قسم علوم الأغذية - كلية الزراعة - جامعة الزقازيق- مصر

يعتبر الشعير من أقدم محاصيل الحبوب وأهمها، كما يعتبر مصدر غذائي مهم في كثير من بلدان العالم، أجرى هذا البحث لمعرفة تأثير الإنبات والطبخ تحت تأثير الضغط على التركيب الكيميائي وبعض مضادات التغذية المختلفة (حمض الفيتك، التانينات، مثبطات التربسين) لدقيق الشعير العاري (صنف جيزة ١٣١)، أوضحت المعاملات التصنيعية تأثيرها على محتويات كلا من البروتين، الأحماض الأمينية، والأملاح، الألياف، عوامل مضادات التغذية، فقد أدى الإنبات إلى زيادة محتويات كلا من البروتين، والألياف، والكالسيوم الى٩,٨٦ %، ١,٥٨%، ٧٥,٨٩مجم/جم على التوالي، كما أدى الإنبات إلى زيادة جميع الأحماض الأمينية الأساسية، على عكس الطبخ تحت تأثير الضغط الذى أدى إلى انخفاض محتويات كلا من البروتين، والألياف، والكالسيوم إلى ٨,٥٦%، ١,٢٤، ٥٤,١٢ مجم/جم على التوالي، وقد لوحظ أن كلا من الإنبات والطبخ تحت تأثير الضغط أدى إلى انخفاض محتويات كلا من الدهن، الرماد، والفوسفور، الحديد، والزنك، كما أدي الطبخ تحت تأثير الضغط إلى أعلى انخفاض لجميع عوامل مضادات التغذية (حمض الفيتك، التانينات، مثبطات التربسين)، وقد لوحظ أن أعلى انخفاض كان في مثبطات التربسين بنسبة ٦١,٤% يليها حمض الفيتك ٥١,٢%.

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