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CHANGES OCCURRING IN DIFFERENT NUTRIENTS OF WHITE KIDNEY BEANS AS AFFECTED BY PROCESSING

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ABSTRACT

The chemical composition of two varieties of white kidney beans namely Bronco and Nibraska were studied and compared. The highest content of crude protein was found in Bronco variety (26.98%) on dry weight basis compared to that found in Nibraska variety (25.79%). Also, the highest content of ash, ether extract and total carbohydrates were found in Nibraska variety compared to that found in Bronco variety. Available carbohydrates in both raw and processed white kidney beans varieties and the effect of processing treatments were studied and the obtained results indicated that the available carbohydrates showed pronounced decrease due to processing in reducing sugars, non- reducing sugars and starch in both varieties. The amino acids were determined for raw and processed samples. The soaking process in tap water for 12 hours resulted in an increase of some amino acids. On contrary, both cooking either directly or after soaking caused slightly destruction of all amino acids in the two varieties. Also, the soaking process caused a slight increase in amino acid scores from 56.98 to 58.03 and 55.71 to 57.19 in Bronco and Nibraska varieties, respectively. However, the cooking process caused a decreasing trend in amino acid scores. Minerals content of all samples as well as the effect of processing were studied, showing a decrease in all minerals under study. The highest decreasing values were for potassium and sodium, but the lowest one was for iron in both varieties. Conclusively, the soaking before cooking improved all sensory properties for the cooked white kidney beans especially in both texture and flavor.

Keywords: White kidney beans (*Phaseolus vulgaris L.*), chemical composition, available carbohydrates, amino acids, minerals and processing.

INTRODUCTION

On a worldwide basis, legumes play an important role in human nutrition. Compared to oilseeds, dry beans have received less attention in the past. A renewed interest in dry beans as a human food is however evident in recent years (Sathe *et al.*, 1983). Also legumes appeared to have great popularity at a faster rate in the food service segment as they are easy to be prepared, suitable for batch cooking time, reheatable, and can be controlled (Morrow, 1991). Legumes are considered to be a very important source of proteins, minerals and vitamins for millions of people all over the world, particularly in developing countries. Besides, the improvement of productivity, adaptability, and yield stability in legumes grains, have gained worldwide attention and is needed to improve the nutritional quality of legumes grain either by progressive breeding techniques and/or following new suitable developed processing methods. In this context, the monitoring of newly developed genotypes of legumes grain for cooking quality and various nutritional attributes have been emphasized (Singh and Singh, 1992).

On the other hand, Aykroyd and Doughty (1977) reported that beans (*Phaseolus vulgaris L,*), which are widely grown and consumed all over the

world, are considered to be among the excellent sources of proteins (20-25%), carbohydrates (50-60%) and fairly good sources of minerals and vitamins.

It is well established that soaking of beans before cooking is a common practice to soften texture and hasten the cooking process. Soaking are also been suggested for reducing the anti-nutritional substances and the improving cooking quality (Wah *et al.*, 1997).

Rehinan *et al.* (2004) stated that the legumes are usually cooked by a boiling process before use. Pressure cookers and microwave ovens, however, could also be used for that purpose. Cooking encourage a lot of changes in both physical characteristics and chemical composition of legumes.

Thus, the aim of this study was to investigate the effects of some processing technological procedures such as soaking and cooking methods on the contents of available carbohydrates, amino acids and minerals in white kidney beans varieties (Bronco and Nibraska). Besides, to choose the optimum treatment for maintaining the nutritional attributes of white beans without being impaired.

MATERIALS AND METHODS

Materials:

White kidney beans (*Phaseolus vulgaris L.*), varieties Bronco and Nibraska were obtained from the Agriculture Research Center, Giza, Egypt.

Methods:

White kidney beans were sorted from broken seeds, dust and other foreign materials then subjected to soaking treatment prior to cooking process. Soaking was performed in tap water at room temperature (25±5°C) for 12 hours then drained. Conventional cooking was used for cooking white kidney beans varieties with and without soaking. Conventional cooking was carried out using boiling water on direct flame (the normal way of cooking beans in the most regions of Egypt) until a degree of tenderness of beans was achieved. Thereafter, processed white kidney beans samples were dried in hot air oven at 55°C until reaching a constant weight (48 hours), then ground to pass through a 1-mm mesh sieve and packed in tight polyethylene pouches, which were sealed under vacuum and stored at room temperature (25±5°C) before chemical analysis.

Moisture, ash, ether extract, crude fiber, crude protein (Nx6.25), reducing sugars, total soluble sugars and starch contents were determined according to the methods described in the A.O.A.C. (2000).

Amino acids were determined using Mikrotechna AAA 881 automatic Amino Acid Analyzer to the method described by Moore and Stein (1963). Hydrolysis of the samples was performed in the presence of (6 Mollar, Hydrochloric acid) at 110°C for 24 hours under nitrogen atmosphere. Sulphur-containing amino acids were determined after performic acid oxidation. Meanwhile, tryptophan content was chemicaly determined by the method of Miller (1967).

The chemical score based on the amino acids of the whole egg protein was performed according to the method used by Bhatty *et al.* (1976) to estimate the protein quality using the following equation:

$$\text{Chemical score} = \frac{\text{g EAA/100g protein of sample}}{\text{g of same EAA/100 g of whole egg protein}} \times 100$$

The lowest percentage has been taken as the chemical score. While, the amino acid score was based on the FAO/WHO standard protein (1990).

$$\text{Amino acid score} = \frac{A}{B} \times 100$$

Whereas:

$$A = \frac{\text{g EAA/100g protein of sample}}{\text{The total of EAA of sample}} \times 100$$

$$B = \frac{\text{g EAA/100g protein of sample}}{\text{The total of EAA of FAO/WHO}} \times 100$$

The lowest percentage has been taken as the amino acid score.

Minerals including sodium (Na), calcium (Ca) and potassium (K) were estimated using emission flame photometer (Model Corning 410). The other minerals such as magnesium (Mg), iron (Fe), zinc (Zn) and copper (Cu) were determined using Atomic Absorption Spectrophotometer (Perkin-Elmer Instrument Model 2380). Whereas, phosphorus (P) was spectrophototmetrically determined according to the method of Rangana (1978).

Organoleptic evaluation: The taste, color, texture and overall acceptability of cooked white kidney beans varieties were subjectively assessed using ten expert panelists of food science and technology. The panelists were asked to check the properties which could describe the samples and score them for acceptability based on hedonic scale as mentioned by Rangana (1978). The data were statistically analyzed according to Ott (1984).

RESULTS AND DISCUSSION

Chemical composition of raw white kidney beans varieties:

Results in Table (1) show differences in the chemical constituents of the two varieties of white kidney beans (Bronco and Nibraska varieties). From these results, it could be observed that the Nibraska variety contains the highest values of ash content (4.11%), ether extract (1.96%) and total carbohydrates (63.28%) on dry weight basis. On the other hand, Bronco variety had a higher values of crude protein (26.98%) and crude fibers (5.63%) on dry weight basis compared to Nibraska variety. These results

indicate that the white kidney beans varieties proved to be good sources of both proteins and carbohydrates. These results are in partial agreement with those obtained by (Aykroyd and Doughty, 1977), who reported that the beans (*Phaseolus vulgaris L.*) are excellent sources of proteins (20-25 %) and carbohydrates (50-60%).

Table (1): Chemical composition of raw white kidney beans varieties

Components	White kidney beans varieties			
	Bronco		Nibraska	
	FWB*	DWB**	FWB	DWB
Crude protein (N x 6.25) %	24.37	26.98	23.07	25.79
Crude fiber (%)	5.09	5.63	4.35	4.86
Ash (%)	3.59	3.97	3.68	4.11
Ether extract (%)	1.69	1.87	1.75	1.96
Total carbohydrates (%)	55.59	61.54	56.60	63.28
Starch (%)	41.34	45.77	41.88	46.82
Total soluble sugars (%)	9.28	10.27	9.95	11.12
Reducing sugars (%)	0.76	0.84	0.89	0.99
Non-reducing sugars (%)	8.52	9.43	9.06	10.13
Moisture content (%)	9.67	-	10.55	-

* FWB = Fresh weight basis
** DWB = Dry weight basis.

Effect of soaking and cooking processes on available carbohydrates content of white kidney beans varieties:

Results in Table (2) show the available carbohydrates content of raw, soaked and cooked white kidney beans varieties. Reducing, non-reducing, total soluble sugars and starch contents in raw white beans (Bronco and Nibraska varities) were 0.84, 0.99%: 9.43, 10.13 %; 10.27, 11.12% and 45.77 and 46.82 % on dry weight basis, respectively. Results indicate that soaking process of two varieties of white kidney beans caused a decrease in the quantity of available carbohydrates content.

Table (2): Available carbohydrates content (%) of both raw and processed white kidney beans varieties(on dry weight basis)

Constituents	Bronco variety						Nibraska variety					
	1	2	3	Change (%)	4	Change (%)	1	2	3	Change (%)	4	Change (%)
Reducing sugars	0.84	0.57	0.35	- 58.33	0.41	- 51.19	0.99	0.73	0.46	- 53.54	0.52	- 47.47
Non-reducing sugars	9.43	8.32	6.14	- 34.89	6.35	- 32.66	10.13	8.94	6.27	- 38.10	6.76	- 33.27
Total soluble sugars	10.27	8.89	6 49	- 36.81	6.76	- 34.18	11.12	9.67	6.73	- 39.48	7.28	- 34.53
Starch	45 77	40 72	31.50	- 31 18	32.84	- 28 25	46.82	41.46	33.25	- 28.98	34.58	- 26.14
Available carbohydrates	56.04	49.61	37.99	- 32.21	39.60	- 29.34	57.94	51.13	39.98	- 31.00	41.86	- 27.75

(1):Raw (control), (2): Soaked in tap water (12 hrs), (3): Soaked then cooked by conventional method, (4):Cooked without soaking.

Therefore, from these data (Table 2), it could be clearly observed that water-soaking process for 12 hours decreased reducing, non-reducing, total soluble sugars and starch contents in Bronco and Nibraska beans varieties, which became 0.57, 0.73%; 8.32, 8.94%; 8.89, 9.67% and 40.72 and 41.46% (on dry weight basis), respectively.

Generally, reduction in the levels of available carbohydrates with soaking treatment may be mainly due to their solubility in water. Also, legume starch is composed of soluble and insoluble portions and as a result of soaking process, the soluble portion was extracted and consequently caused reduction in starch content.

On the other hand, available carbohydrates i.e .total soluble sugars, reducing, non-reducing sugars and starch contents decreased as a result of cooking processes. Destruction percentages of available carbohydrates of these white beans were higher in the conventional cooking after being soaked in tap water than without soaking. Destruction percentages were 36.81, 39.48%; 34.18, 34.53 %; 31.18, 28.98 % and 28.25 and 26.14% for total soluble sugars and starch contents in Bronco and Nibraska beans after cooking with and without soaking, respectively (Table 2). These decrements in available carbohydrates content of white beans were essentially due to both solubility of sugars in boiling water and the enzymatic hydrolysis of polysaccharides during cooking process. These results are in full agreement with those obtained by Rehman *et al.* (2001), who stated that soaking and cooking methods caused an obvious loss in different nutrients, including available carbohydrates.

Effect of soaking and cooking processes on amino acids composition of white kidney beans varieties:

Amino acids composition of raw, soaked and cooked of the aforementioned varieties of white kidney beans under investigation, i.e. (Bronco and Nibraska) are presented in Tables (3 and 4).

Table (3): Amino acid composition (g/16 g N) of both raw and processed white kidney beans (Bronco variety)

Amino acids	1	2	3	Change (%)	4	Change (%)
Isoleucine	4.13	4.10	3.83	-7.26	3.69	-10.65
Leucine	7.42	7.45	7.25	- 2.29	7.11	- 4.18
Lysine	6.35	6.39	6.26	- 1.42	6.15	- 3.15
Methionine	1.16	1.21	1.03	- 11.21	0.99	- 14.66
Cystine	0.89	0.86	0.78	- 12.36	0.76	- 14.61
Phenylalanine	4.94	4.82	4.72	- 4.45	4.65	- 5.87
Tyrosine	2.48	2.37	2.25	- 9.27	2.21	- 10.89
Threonine	3.97	3.78	3.64	- 8.31	3.57	- 10.08
Tryptophan	0.94	1.15	0.86	- 8.51	0.83	- 11.70
Valine	5.72	5.60	5.54	- 3.15	5.43	- 5.07
Total E.A.A*	38.00	37.73	36.16	- 4.84	35.39	- 6.87
Arginine	6.12	5.98	5.43	- 11.27	5.26	- 14.05
Histidine	2.97	2.99	2.40	- 19.19	2.31	- 22.22
Aspartic acid	10.98	10.93	10.72	- 2.37	10.45	- 4.83
Glutamic acid	15.95	14.64	14.37	- 9.91	14.18	- 11.10
Glycine	3.94	3.72	3.53	- 10.41	3.50	- 11.17
Proline	3.75	3.54	3.42	- 8.80	3.35	- 10.67
Serine	5.57	5.54	5.40	- 3.05	5.22	- 6.28
Alanine	4 45	4.26	4.20	- 5.62	4.13	- 7.19
Total N.E.A.A**	53.73	51.60	49.47	- 7.93	48.40	- 9.92
Total amino acids	91.73	89.33	85.63	- 6.65	83.79	-8.66

*** Total E.A.A = Total essential amino acids**

**** Total N.E.A.A. = Total non-essential amino acids**

(1): Raw (control), (2): Soaked in tap water (12 hours).

(3): Soaked then cooked by conventional method., (4): Cooked without soaking.

These results indicate that the legumes could be considered a good source of lysine, but had low content in sulphur amino acids (methionine and cystine). Leucine and lysine had the highest amounts in both raw and treated samples, which were 7.42, 6.35; 7.45,6.39;7.25,6.26; 7.11 and 6.15 and 6.48,7.24; 6.53,7.30; 6.34, 7.12 and 6.15 and 6.93 gm/16gm N. for raw and processed white kidney beans varieties, respectively (Tables 3 and 4).These results are in full agreement with those demonstrated by Eggum and Beame (1983),who reported that sulphur-containing amino acids and tryptophan are the most limiting amino acids of legumes.

Soaking process of raw white kidney beans in tap water for 12 hours before cooking caused moderate increments in some essential and non-essential amino acids. The levels of some amino acids increased due to the hydrolysis and breakdown of proteins by proteolytic enzymes essentially during soaking process.

The most liable amino acids to destruction process during cooking were 11.21, 11.61; 12.36, 10.71; 11.27, 17.65 and 19.19 and 21.33 % for methionine , cystine, arginine and histidine amino acids for cooking after soaking in Bronco and Nibraka varieties, respectively.

However, the decrement percentages of amino acids due to direct cooking without soaking were increased to reach 14.66, 14.29; 14.61, 13.10; 14.05,19.33 and 22.22 and 23.43 % for methionine, cystine , arginine and histidine amino acids for Bronco and Nibraska varieties , respectively.

Table (4): Amino acid composition (g/16 g N) of both raw and processed white kidney beans (Nibraska variety)

Amino acids	1	2	3	Change(%)	4	Change(%)
Isoleucine	3.89	3.84	3.62	- 6.94	3.49	-10.28
Leucine	6.48	6.53	6.34	- 2.16	6.15	- 5.09
Lysine	7.24	7.30	7.12	- 1.66	6.93	- 4.28
Methionine	1.12	1.19	0.99	- 11.61	0.96	- 14.29
Cystine	0.84	0.80	0.75	- 10.71	0.73	- 13.10
Phenylalanine	5.25	5.10	4.98	- 5.14	4.92	- 6.29
Tyrosine	2.66	2.40	2.35	- 11.65	2.30	- 13.53
Threonine	4.12	3.90	3.75	- 8.98	3.64	- 11.65
Tryptophan	0.96	1.21	0.86	- 10.42	0.84	- 12.50
Valine	4.63	4.54	4.42	- 4.54	4.28	- 7.56
Total E.A.A*	37.19	36.81	35.18	- 5.40	34.24	- 7.93
Arginine	5.95	5.67	4.90	- 17.65	4.80	- 19.33
Histidine	2.86	2.92	2.25	- 21.33	2.19	- 23.43
Aspartic acid	11.65	11.58	11.20	- 3.86	10.92	- 6.27
Glutamic acid	14.68	13.85	13.36	- 8.99	13.23	- 9.88
Glycine	3.78	3.52	3.35	- 11.38	3.28	- 13.23
Proline	4.49	4.26	4.18	- 6.90	4.11	- 8.46
Serine	4.67	4.62	4.47	- 4.28	4.30	- 7.92
Alanine	4.61	4.49	4.32	- 6.29	4.15	- 9.98
Total N.E.A.A**	52.69	50.91	48.03	- 8.84	46.98	- 10.84
Total amino acids	89.88	87.72	83.21	- 7.42	81.22	-9.64

*** Total E.A.A = Total essential amino acids**

**** Total N.E.A.A. = Total non-essential amino acids**

(1): Raw (control), (2): Soaked in tap water (12 hours).

(3): Soaked then cooked by conventional method., (4): Cooked without soaking.

Amino acid scores of raw and processed white kidney beans varieties are presented in Table (5). These results indicate that amino acid scores were slightly increased due to soaking process. This could be ascribed to the function of proteolytic enzymes activated by the soaking process. These results are in accordance with those obtained by El -Waseif (1997).

This phenomenon was true in both varieties under investigation. However, all the essential amino acid scores obviously decreased due to the thermal treatment (Table 5).

Table (5): Amino acid score of both raw and processed white kidney beans varieties according to FAO/WHO (1990)

Essential amino acids	FAO/WHO (1990) pattern	Bronco variety				Nibraska variety			
		1	2	3	4	1	2	3	4
Isoleucine	4.0	100.56	100.56	97.96	96.48	96.76	96.48	95.19	94.26
Leucine	7.0	103.22	104.39	105.97	106.18	92.07	93.76	95.24	94.93
Lysine	5.5	112.45	113.99	116.49	116.96	131.02	133.45	136.20	136.20
Methionine + Cystine	3.5	56.98	58.03	53.17	52.22	55.71	57.19	52.33	52.20
Phenylalanine+ Tyrosine	7.0	103.22	100.74	101.43	102.43	112.42	107.66	110.15	109.88
Threonine	4.0	96.67	92.69	93.15	93.34	102.50	97.96	98.61	98.33
Tryptophan	1.0	91.48	112.96	88.15	87.04	95.56	121.85	90.37	90.74
Valine	5.0	111.40	109.84	113.40	113.55	92.15	91.27	92.97	92.52
Amino acid score	-	56.98	58.03	53.17	52.22	55.71	57.19	52.33	52.20

(1):Raw (control), (2): Soaked in tap water (12 hrs), (3): Soaked then cooked by conventional method, (4):Cooked without soaking.

In addition, chemical scores and limiting amino acids of raw and processed white kidney beans varieties are presented in Table (6).

Table (6): Chemical score and limiting amino acids of raw and processed white kidney beans varieties

Essential amino acids	Whole egg protein	Bronco variety				Nibraska variety			
		1	2	3	4	1	2	3	4
Isoleucine	6.6	62.58	62.12	58.03	55.91	58.94	58.18	54.85	52.88
Leucine	8.0	92.75	93.13	90.63	88.88	81.00	81.63	79.25	76.88
Lysine	6.6	96.21	96.82	94.85	93.18	109.70	110.61	107.88	104.99
Methionine + Cystine	5.4	37.96	38.33	33.52	32.41	36.30	36.85	32.22	31.30
Phenylalanine+ Tyrosine	10.8	68.70	66.57	64.54	63.52	73.24	69.44	68.80	66.85
Threonine	5.0	79.40	75.60	72.80	71.40	82.40	78.00	75.00	72.80
Tryptophan	1.5	62.67	76.67	57.33	55.33	63.99	80.67	57.33	55.99
Valine	7.4	77.30	75.68	74.86	73.37	62.57	61.35	59.73	57.84
First limiting A.A.	-	Met + Cys	Met + Cys	Met + Cys	Met + Cys	Met + Cys	Met + Cys	Met + Cys	Met + Cys
Second limiting A.A.	-	Isoleu	Isoleu	Tryp	Tryp	Isoleu	Isoleu	Isoleu	Isoleu

(1):Raw (control), (2): Soaked in tap water (12 hrs), (3): Soaked then cooked by conventional method, (4):Cooked without soaking.

These results indicate that the first limiting amino acids in all treatments were sulphur amino acids (methionine plus cystine). However, in case of second limiting amino acids a variable trend existed since isoleucine and tryptophan were the second limiting amino acids for raw, soaked and cooked Bronco variety. Meanwhile, for Nibraska variety isoleucine was the

second limiting amino acid in all cases including raw, soaked and cooked Nibraska variety.

In spite of ,the higher protein percentages of both varieties, however, the protein biological quality was inferior indicated that low amino acid scores, which were 52.22 and 52.20 for direct cooking and 53.17 and 52.33 for cooking after being soaked for Bronco and Nibraska varieties, respectively.

Effect of soaking and cooking processes on some minerals content in white kidney beans varieties:

Minerals content in both raw and treated white kidney beans varieties (Bronco and Nibraska) are presented in Table (7). These results indicate that the white beans are considered to be among the good sources of minerals such as , potassium (K), calcium (Ca), phosphorus (P) and iron (Fe) for the human diet. Also, white beans contained the trace elements such as , copper (Cu), zinc (Zn) and magnesium (Mg). Results in Table (7) indicate that the main minerals in white beans varieties were K. Ca, P and Fe. White kidney beans varieties contained 1459.42, 1352.75; 156.18,150.32; 465.57, 479.56 and 6.48 and 7.54 mg/100gm (on dry weight basis) for K, Ca. P. and Fe in Bronco and Nibraska beans varieties, respectively. Soaking and cooking processes caused losses in all minerals in treated samples. On the other hand, cooking after soaking decreased mineral contents more than being cooked without soaking of white kidney beans varieties (Table 7).

These results indicate that the highest elements losses were potassium and sodium due to both extensive leaching into the cooking water and the increase in thermal destruction. These obtained results are similar to those demonstrated by Rincon *et al.* (1993), who reported that most of the macro and micro nutrients, particularly vitamins and minerals, are lost during these soaking and cooking processes.

Table (7): Mineral contents (mg/100 gm) of both raw and processed white kidney beans varieties (on dry weight basis).

Minerals	Bronco variety						Nibraska Variety					
	1	2	3	Change (%)	4	Change (%)	1	2	3	Change (%)	4	Change (%)
Potassium (K)	1459.42	1287.84	1129.84	- 22.58	1194.38	- 18.16	1352.75	1201.95	1038.85	- 23.20	1122.47	- 17.02
Sodium (Na)	31.74	26.12	22.79	- 28.20	25.86	- 18.53	33.85	28.56	25.24	- 25.44	28.94	- 14.51
Calcium (Ca)	156.18	139.75	127.54	- 18.34	132.75	- 15.00	150.32	134.65	124.71	- 17.04	132.83	- 11.64
Phosphorus (P)	465.57	436.58	418.48	- 10.11	425.44	- 8.62	479.56	448.87	431.39	- 10.04	440.95	- 8.05
Iron (Fe)	6.48	6.10	5.85	- 9.72	5.97	- 7.87	7.54	7.12	6.67	- 11.54	6.94	- 7.96
Copper (Cu)	0.92	0.85	0.81	- 11.96	0.83	- 9.78	0.75	0.71	0.66	- 12.00	0.68	- 9.33
Zinc (Zn)	3.23	2.98	2.73	- 15.48	2.85	- 11.76	2.94	2.77	2.52	- 14.29	2.61	- 11.22
Magnesium (Mg)	136.53	128.38	120.68	- 11.61	122.43	- 10.33	131.47	125.20	115.24	- 12.35	118.96	- 9.52

(1):Raw (control), (2): Soaked in tap water (12 hrs), (3): Soaked then cooked by conventional method, (4):Cooked without soaking.

Sensory evaluation of cooked white kidney beans:

Consumer acceptability should be highly considered. Accordingly, the organoleptic scores for panel test are tabulated in Table (8), which will reflect the preference trend of consumers. These results indicate that there were

significant differences between soaked and unsoaked dry beans after being conventionally cooked in both tested varieties.

It seems that the soaking process was very essential to improve the sensory properties of both taste and texture. The overall acceptability scores also emphasized such trend in both varieties. Soaking process also obviously shortened the time of cooking and improved both color and texture of the cooked products.

Conclusively, the sensory scores of both varieties slightly differed. However, the overall acceptability scores were higher in the case of Bronco variety than in the Nibraska one (Table 8).

Table (8):Organopleptic evaluation of cooked white kidney beans varieties.

Cooked white beans	Taste	Color	Texture	Overall acceptability
Bronco variety:				
- with soaking	8.24±0.62	8.75±0.67	8.77±0.98	8.86±0.26
- without soaking	7.61±0.48	7.34±0.41	7.65±0.71	7.54±0.65
L.S.D. at < 0.05	0.213	0.207	0.217	0.130
Nibraska variety:				
- with soaking	8.15±0.83	8.67±0.77	8.12±0.87	7.71±0.71
- without soaking	6.25±0.60	6.94±0.57	7.65±0.97	6.82±0.33
L.S.D. at < 0.05	0.189	0.218	0.140	0.230

*Values are means ± standard deviation.

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التغييرات التي تحدث في المكونات الغذائيـــة المختلفة فـــي الفاصـــوليا البيضـــاء كنتيجة لعمليات التصنيـــــع

سعـــد ميخائيـــل يوسف

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تم دراسة التركيب الكيماوي لصنفين من الفاصوليا البيضاء وهما برونكو ونبراسكا ومقارنتهما ٠ وتميز الصنف (برونكو) بارتفاع محتواه من البروتين الخام (٢٦,٩٨%) على أساس الوزن الجاف مقارنة بتلك الموجودة في الصنف نبراسكا (٢٥,٧٩%)٠وأيضا وجد ان الصنف (نبراسكا) يتميز بارتفاع محتواه من الرماد والمستخلص الاثيرى و الكربوهيدرات الكليه مقارنة بتلك الموجودة في الصنف (برونكو)٠

كذلك تم دراسة محتوى صنفي الفاصوليا البيضاء الخام والمصنعة من الكربوهيـــدرات المتاحـــة ومدى تأثير العمليات التصنيعية عليها حيث تبين وجود انخفاض واضح في الكربوهيدرات الموجودة كنتيجة لعمليات التصنيع و في كل من السكريات المختزلة والغير مختزلة والنشا في كلا الصنفين ٠

وتم أيضا تقديـــر الأحماض الأمينية بواسطة جهاز Amino Acid Analyzer في العينـــات الخام والمصنعة ووجد ان عملية النقع في الماء العادي لمدة ١٢ ساعة نتج عنه زيادة في بعض الأحماض الأمينية ، وعلى العكس من ذلك فإن عملية الطبخ سواء كانت بعد النقع او مباشرة بدون نقع أدت إلي حدوث تكسير بسيط في كل الأحماض الأمينية في كلا الصنفين ٠ كما أدت عملية النقع الى حدوث زيادة بسيطة في دليل الأحماض الأمينية Amino acid scores من (٥٦,٩٨ الى ٥٨,٠٣) ومن (٥٥,٧١ الـــى ٥٧,١٩) في الصنفين برونكو ونبراسكا على التوالي ، في حين أن عملية الطبخ تسببت في حدوث إنخفاض في دليـــل الأحماض الأمينية ٠ وأيضا تم دراسة المحتوى من العناصر المعدنية في جميع العينات ، كانت أعلى قـــيم للنقص في عنصري البوتاسيوم والصوديوم ولكن اقل القيم نقصا كانت لعنصر الحديد في كلا الصنفين٠

واخيرا يمكن القول بأن عملية النقع قبل الطبخ قد أدت إلي تحسين جميـــع الخصـــائص الحســـية للفاصوليا البيضاء المطبوخة خاصة في كل من القوام والنكهة٠