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EFFECT OF SOAKING ON THE COOKING QUALITY AND COLOUR PARAMETERS OF COMMON BEANS (*Phaseolus Vulgaris L.)*

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Abstract: *The purpose of this paper was to determine the colour changes under the influence of beans soaking in sodium bicarbonate solution, followed by drying, to obtain dry beans with a reduced cooking time. Two common beans varieties were stored in a cabinet at room temperature and their organoleptic properties were analyzed.*
The colour changing from the different treatments soaking beans samples was measured by lightness values (L), chroma index parameter (C*) and hue angle or coloration (H*) values. The result indicated a change in Hunter parameters, L* and C*.*
Soaking in sodium bicarbonate solution produced significant reductions in cooking time for dry beans of the two varieties. The cooking time decreased from 120 min to 75 when using 5% sodium bicarbonate soaking solution for white beans, and 60 to 30 min for the red beans, respectively.

Keywords: *dry beans, soaking effects, colour, cooking time.*

1. Introduction

Beans *(Phaseolus vulgaris L.)* are a leguminous plant used since Antiquity in human nutrition. Epidemiological studies show that the biochemical composition of beans reduces and prevent the risk of several chronic and degenerative diseases such as cancer, cardiovascular diseases, diabetes, overweight and obesity. These legumes are rich in complex carbohydrates, protein, vitamins, minerals and poor in fats.
According to Kaloustian, J., et al., 2008, dry beans contain several phytosterols, phytosterols are known to have hypocholesterolemic properties. Phytosterol potency in decreasing serum atherogenic low-density lipoprotein (LDL) cholesterol levels and thus, in protecting against cardiovascular diseases, mainly coronary heart disease, has led to the development of functional foods enriched with plant sterols [1].
Carbohydrates constitute the main fraction of beans (55%–65% dry weight on average) with polysaccharides as the major constituents, and small but significant amounts of oligosaccharides (31%–76% of total sugars) [2]. Dry beans are digested slowly and have low glycemic index values.
Legumes have a higher content in minerals than cereals. Most legumes, including common beans, are consumed as a whole and as a result their mineral content is preserved [3]. Beans are an important source of iron, phosphorus, magnesium,

manganese, and in lesser degree, zinc, copper and calcium.

Beans are an excellent source of vitamins: vitamins A, C, E, K and PP, B vitamins and folic acid. According to Kabagambe, E. K., et al., 2005, the importance of beans is shown by their contribution to protein, fibre and micronutrients in food; in the Costa Rican diet, beans contributed 11% of protein, 25% of fibre, 17% of folate, 5% of vitamin B-6, 5% of magnesium, 14% of copper, and 13% of iron [4].

The amount of folic acid can be lost from dried beans and other vegetables during the cooking and soaking process. Quick-soaking beans (boiling beans for a short time and then soaking for one hour) may lead to more folate losses than a more traditional long soak [5]. Julie Garden-Robinson and Krystle McNeal, 2013 suggest using the slow-soak method and a cooking method that prepares the beans in 150 minutes to minimize loss of natural folate content in beans.

Kutoš, T., et al., (2003), determine and compare soluble dietary fibre (SDF), insoluble dietary fibre (IDF) and total dietary fibre (TDF) in raw, soaked and cooked beans, before and after the correction for the resistant starch—RS portion. The results confirm that processing of beans significantly affected ($P \leq 0.001$) all the parameters analyzed, except for water content ($P \leq 0.01$) [6].

The potential benefits of common beans on health are attributed to the presence of secondary metabolites such as phenolic compounds that have antioxidant properties [7]. The beans with the highest polyphenolic content are the dark, highly pigmented varieties, such as red or brown beans rather than white beans [8].

Broughton, W. J., et al., 2003, reported the phytic acid (myo-inositol hexaphosphate) and its salts (phytates) represent between 54 and 82% of the phosphorous content of the bean i.e. between 0.5 and 1.6% of the seed weight [3]. Midorikawa K, et al., 2001, have studied the applications of phytic acid in food, medicine and metal anti-oxidation. According to Midorikawa K, et al., 2001 phytate has also been implicated in the reduction of cholesterol and other lipids due to its presence in high fibre diets [9].

Beans as legumes contain some anti-nutritional components that may have adverse effects on human nutrition, these are mainly phenols, tannins, phytic acids and enzyme inhibitors. These components might reduce the nutritional quality of dry beans even if they are present in low concentrations. Low utilization of dry beans in food has been attributed to inconvenience due to prolonged cooking and general gastrointestinal distress experienced after eating bean products.

Fernandes, A., C. et ales 2010, studied a systematic review of the influence of maceration (of different soaking solutions other than pure water – sodium chloride (NaCl), sodium bicarbonate ($NaHCO_3$) and mixed (NaCl + $NaHCO_3$)) on the nutritional quality of common beans (*Phaseolus vulgaris L.)* cooked with or without the soaking water, and recommend the soaking water to be discarded as eliminating the anti-nutritional factors. This procedure appears to reduce some of the carbohydrate fraction of the beans and may reduce or maintain the contents of fibres. This method also reduced phytates, phytic acid, total phenolics and tannins. However, in the study by Nergiz, Cevdet, and Erkan Gökgöz, 2007, soaked-cooking and pressure-cooking reduced the phenols on an average of up to 77.37 and 71.17%,

respectively. This reduction in the total phenols may be attributed to their solubilisation in water and heat degradation. Soaking before cooking and discarding the soaking water also seems to be an effective way to reduce the amount of oligosaccharides which produce flatulence.

Audu, S. S. et al., 2013, studied the effect of different processing methods on nutritional composition of a lesser known crop (black turtle bean). Audu, S. S. et al., 2013 reported that the processing methods showed deviations in nutrients from the raw seeds. Raw protein was found to be enhanced by cooking (13.5%), roasting (4.64%) and sprouting (14.35%) methods while all the processing methods were found to reduce the contents of raw fat, fatty acids and metabolizable energy. Processing ($p<0.05$) affected significantly the content of some minerals in *Phaseolus vulgaris* seeds [12].

The aim of the present research is to assess the effect of cooking on surface colour of beans and the effect of soaking on the cooking quality for two varieties of beans.

2. Materials and methods

2.1. Plant material

Dry white and red beans samples, approximately 1 kg each donated by a commercial producer were grown and harvested in Suceava plateau, an area of Romania, during the summer of 2013, and stored at room temperature. Organoleptic properties of the grains were analyzed according to the standard STAS 6253-80, the beans were distinguished by colour, smell and texture and they met the standard requirements.

The samples were first cleaned from broken seeds, dust and other foreign materials. Each sample was divided into two portions. The first portion was used for analysis as raw. The second portion was soaked in different soaking solutions (1:5 w/v) at ambient temperature for 3 h. The soaking solutions contained 1%, 2%, 3%, 4% and 5% sodium bicarbonate in 100 ml distilled water (all percentage wt/vol).

The soaked beans were then cooked (in distilled water bean: water 1/5) and dehydrated in conventional tray dryers to a final moisture content of 10-11%.

2.2. Chemical analyses

The determination of moisture in samples was performed according to the European Standard EN ISO 665/2000 by using the drying process in a drying chamber at the temperature of 103 °C.

Total Kjeldhal nitrogen was determined from which protein contents were calculated by multiplying using the factor 6.25.

Total ash composition was obtained by calcinations of 5g of sample at 600 °C for 240 min.

Content of lipids was determined in a Soxhlet apparatus, extracting the lipids from 10 g of sample with petroleum ether, followed by extract evaporation to dryness and gravimetric determination according to the European Standard EN ISO 659/1998.

The water activity of beans was evaluated with the device Aqua Lab.

Total carbohydrate content of the sample was determined as total carbohydrate by difference, that is by subtracting the measured protein, fat, ash and moisture from 100 [13].

Colour measurements of surface beans have been performed by using a Minolta Chroma Meter (Model CR 310, Minolta Camera Co. Ltd., Japan), based on the by Hunter L* (whiteness/darkness), a*

(redness/greenness), and b* (yellowness/blueness) system.
The values of the hue angle or coloration (H*) of the samples were determined by the expression (1):

$$H^* = tan^{-1}\left(\frac{b^*}{a^*}\right) \qquad (1)$$

in which H* = angle of coloration or chromatic tonality colour; b*= component of the colour red-green; a*= component of the colour yellow-blue [14];
The chroma index parameter (C*), which indicates the chromaticity or colour intensity of the sample was also determined from the results of a* and b* attributes, using the following expression [14]:

$$C^* = \sqrt{(a^*)^2 + (b^*)^2} \qquad (2)$$

in which C* = chroma index; b* = component of the colour red-green; a*= component of the colour yellow-blue;

3. Results and discussion

The moisture content of the samples was 8.00-8.10 %. These values are close to the reported values by several researchers [15,11]. The water content changed significantly due to soaking and cooking.
Protein contents ranged from 21.62 and 23.01 %. Maribel Ovando-Martínez et al., 2011, reported similar protein content for the same varieties of raw beans (higher in the Pinto Durango beans grown under rain fed conditions 27.32 ± 0.08, and 23.14 ± 0.05 for Black 8025 beans). Maribel Ovando-Martínez et al., 2011, reported that the protein content of beans decreased after thermal processing [16]. The proportion of protein that is associated with insoluble dietary fiber may also explain the decrease of protein content in the cooked beans.
Content of carbohydrates of dry beans can be seen in fig 1, water activity of dry beans is illustrated in fig 2 and the chemical composition of raw and cooked beans (moisture%, protein %, lipids % and ash %) are presented in fig. 3.

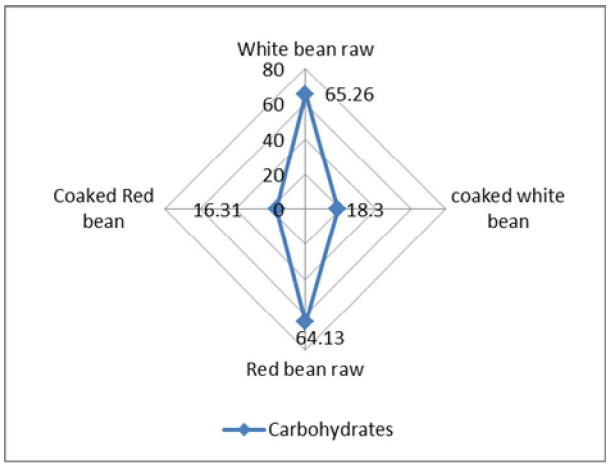


Fig. 1. Content in carbohydrates of dry beans

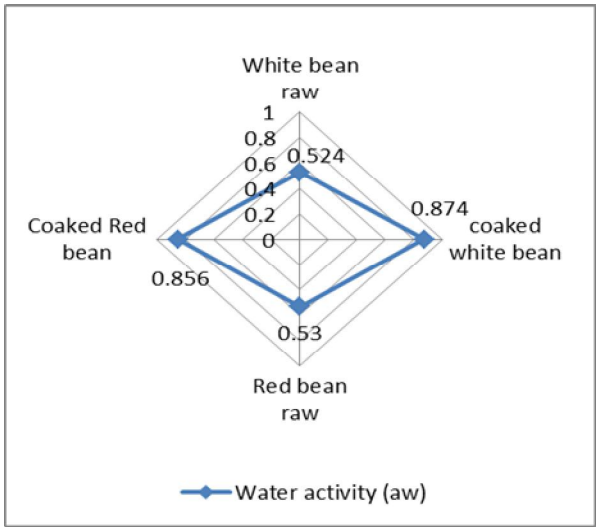
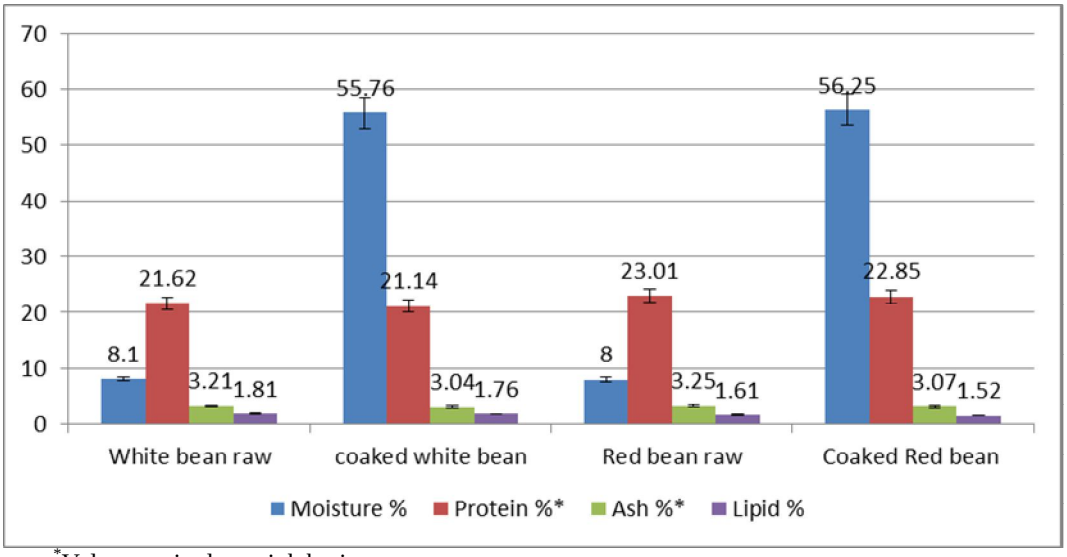


Fig. 2. Water activity of dry beans



*Values are in dry weigh basis

Fig. 3 Chemical composition of dry beans

Myrene R. D'souza 2013, reported similar ash contents for the same varieties of raw beans cultivated in India (3.00±0.02) and the ash content was significantly decreased in all treated (soaking, cooking, roasting, autoclaving and germination) samples with significant decrease found in cooked beans.

Beans also have low water content, with water activity (a_w) ranged from: for white beans 0.524 and up to 0.530 for red beans. Paredes-López,1991 reported all hardening procedures (soaking in acetate buffer, pH = 4.1 at 37^0C for 5h, 37^0C 100 % relative humidity for 28 days and 31-33^0C 76 % relative humidity for 120 days) that enhanced water activities [15].

The effect of soaking solutions on cooking quality. Soaking in sodium bicarbonate solution of different concentrations, followed by drying resulted in a significant reduction of the time for the preparation of both varieties of beans (fig. 4).

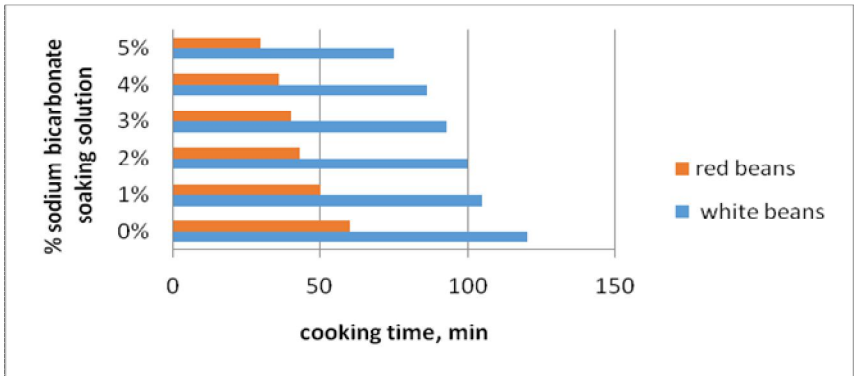


Fig. 4. Influence of soaking solution on the cooking quality of two common beans varieties

The effect of soaking solutions on cooking time of the unprocessed beans

The cooking time of the unprocessed beans was 120 minutes and 60 minutes for white and red beans, respectively (figure 1). The greatest reduction in the cooking time is in the white beans samples (37.50 %), followed by red beans (18.00%).

V. Schoeninger, 2013 investigated the effect of processing beans by soaking, and the bleaching salt solutions to obtain a reduced cooking time for dried beans. According to V. Schoeninger, 2013, the increase in concentration of $NaHCO_3$ from 0 to 4.5% reduced with 9.06 min the cooking time of the aged bean grains.

The effect of sodium bicarbonate in the reduction of the cooking time of the beans has been reported in other researches. Paredes-López, O.,1991 reported that the hardened beans by chemical and storage procedures may be remarkably softened by soaking in NaCl+ $NaHCO_3$ or just $NaHCO_3$.

The effect of soaking solutions on colour parameter of surface beans

Table 1 shows the parameter changes in colour according to the different proportions in sodium bicarbonate in which the studied beans were soaked. The Colour parameter studied was the lightness, L*, which is a colorimetric parameter extensively used to characterize the variation of colours in foods during processing [17].

Table 1

Colour parameters of surface beans in control and pre-processing beans under soaking condition in sodium bicarbonate solutions followed by drying

Samples	$NaHCO_3$ (%)	L^*	H^*	C^*
White beans				
Raw beans (control)	-	122.36	-62.13	132.45
S1	1	122.06	-61.86	62.91
S2	2	117.53	-57.00	111.50
S3	3	118.03	-57.83	97.51
S4	4	121.86	-56.30	122.28
S5	5	111.10	-58.78	82.78
Red beans				
Raw beans (control)	-	114.80	-63.20	103.49
S1	1	110.13	-58.15	84.18
S2	2	103.80	-60.11	74.93
S3	3	105.83	-57.66	97.33
S4	4	108.60	-57.99	81.39
S5	5	103.16	-46.12	82.89

L^*=luminosity; H^*= colouring angle; C^*= croma index;

The two varieties had a reduction in the L^* value when compared to the pre-processed beans (table 2).

Soaked white beans presented a variation between 122.06 and 111.10 whereas the control white beans presented a value of 122.36 for lightness, L*, parameter. The L^* values for red beans were similar and ranged from 114.80 in control sample to 103.16 for 55 sodium bicarbonate solution soaking. There have been observed decreases also in the values of the chroma index (C*) and coloring angle (H*) of the soaked beans compared to the raw sample. However, both chroma and hue angle values of soaking beans had a small variation range, which showed that the colour differences were smaller in red

beans than those observed in white beans. The chroma parameter is an indicator of the colour intensity perceived by the human vision, the higher the value from parameter the greater the chromatic tonality of the samples. The H* parameter is understood as tonality and defines the basic coloring of the sample [14]. These results are consistent with the ones of other investigators, Siddiq, M., et al., 2010 reported a beans Hunter color ‘‘L’’ values differed significantly ($p<0.05$) across bean types, with black beans having the lowest (11.49) and red kidney beans with 21.20.

There were no significant changes in the protein and lipid contents after processing the beans, indicating that the pre-processing in sodium bicarbonate solutions followed by drying may be an alternative to reduce the cooking time of the dry beans.

4. Conclusions

Based on the results obtained, it can be concluded that the factors concentration of $NaHCO_3$ presented a strong influence on the following parameters: cooking time, luminosity and colour difference of beans in relation to the control sample. Soaking in sodium bicarbonate solution resulted in a 37.5 % reduction in cooking time for white beans.

The protein, fat, or ash content of raw beans cooked has shown to have minimal or no effect on most of the soaking samples studied.

5. References

[1]. KALOUSTIAN, J., ALHANOUT, K., AMIOT-CARLIN, M. J., LAIRON, D., PORTUGAL, H., & NICOLAY, A. Effect of water cooking on free phytosterol levels in beans and vegetables. *Food chemistry*, *107*(4), 1379-1386 (2008).

[2]. CAMPOS-VEGA, R., OOMAH, B. D., LOARCA-PIÑA, G., & VERGARA-CASTAÑEDA, H. A. Common beans and their non-digestible fraction: cancer inhibitory activity—an overview. *Foods*, *2*(3), 374-392(2013).

[3]. BROUGHTON, W. J., HERNANDEZ, G., BLAIR, M., BEEBE, S., GEPTS, P., & VANDERLEYDEN, J. Beans (Phaseolus spp.)–model food legumes. *Plant and soil*, *252*(1), 55-128 (2003).

[4]. KABAGAMBE, E. K., BAYLIN, A., RUIZ-NARVAREZ, E., SILES, X., & CAMPOS, H. Decreased consumption of dried mature beans is positively associated with urbanization and nonfatal acute myocardial infarction. *The Journal of nutrition*, *135*(7), 1770-1775 (2005).

[5]. GARDEN-ROBINSON J., MCNEAL K., All about beans, *NDSU Food and Nutrition*, pp 1-16(2013).
http://www.ag.ndsu.edu/pubs/yf/foods/fn1643.pdf.

[6]. KUTOŠ, T., GOLOB, T., KAČ, M., & PLESTENJAK, A. Dietary fibre content of dry and processed beans. *Food chemistry*, *80*(2), 231-235(2003).

[7]. CAMPOS-VEGA, R., LOARCA-PIÑA, G., & OOMAH, B. D. Minor components of pulses and their potential impact on human health. *Food research international*, *43*(2), 461-482 (2010).

[8]. MADHUJITH T, NACZK M, SHAHIDI F, Antioxidant activity of common beans (*Phaseolus vulgaris* L), *J. Food Lipids*, 11,220 (2004).

[9]. MIDORIKAWA K, MURATA M, OIKAWA S, HIRAKU Y AND KAWANISHI S., Protective effect of phytic acid on oxidative DNA damage with reference to cancer chem oprevention. *Biochem. Biophys. Res. Commun*. 288, 552–557(2001).

[10]. FERNANDES A. C., WALESKA N., AND DA COSTA PROENÇA R., Influence of soaking on the nutritional quality of common beans *(Phaseolus vulgaris L.)*cooked with or without the soaking water: a review."*International journal of food science & technology* 45.11: 2209-2218(2010).

[11]. NERGIZ, CEVDET, AND ERKAN GÖKGÖZ, Effects of traditional cooking methods on some antinutrients and in vitro protein digestibility of dry bean varieties (*Phaseolus vulgaris L.*) grown in Turkey. *International journal of food science & technology* 42.7 (2007): 868-873 (2007).

[12]. AUDU, S. S., AREMU, M. O., & LAJIDE, L. Influence of traditional processing methods on the nutritional composition of lack turtle bean

(*Phaseolus vulgaris L.*) grown in Nigeria. *International Food Research Journal*, *20*(6), 3211-3220 (2013).
[13]. MYRENE R. D'SOUZA. Effect of Traditional processing Methods on Nutritional Quality of Field Bean, *Advances in Bioresearch*, **Vol. 4 (3),** pp. 29-33 (2013).
[14]. SCHOENINGER V., MACHADO COELHO S. R., DIVAIR CHRIST, SAMPAIO S. C. and BISPO DE ALMEIDA AJ., Pre-processing of aged carioca beans: Soaking effect in sodium salts in the cooking and nutrition quality, *Journal of Food, Agriculture & Environment*, Vol.11 (1*)*, pp. 184 - 189 (2013).
[15]. PAREDES-LÓPEZ, O., CÁRABEZ-TREJO, A., PALMA-TIRADO, L., & REYES-MORENO, C., Influence of hardening procedure and soaking solution on cooking quality of common beans. *Plant Foods for Human Nutrition*, *41*(2), 155-164 (1991).
[16]. OVANDO-MARTÍNEZ, M., OSORIO-DÍAZ, P., WHITNEY, K., BELLO-PÉREZ, L. A., & SIMSEK, S., Effect of the cooking on physicochemical and starch digestibility properties of two varieties of common bean (< i> Phaseolus vulgaris</i> L.) grown under different water regimes. *Food Chemistry*, *129*(2), 358-365(2011).
[17]. LEAHU, A., DAMIAN C., CARPIUC N., OROIAN M., and AVRAMIUC M., Change in colour and physicochemical quality of carrot juice mixed with other fruits. *Journal of Agroalimentary Processes and Technologies* 19: 241-246 (2013).
[18]. SIDDIQ, M., RAVI, R., HARTE, J. B., & DOLAN, K. D. (2010). Physical and functional characteristics of selected dry bean (< i> Phaseolus vulgaris</i> L.) flours. *LWT-Food Science and Technology*, *43*(2), 232-237 (2010).
[19]. STAS 6253-80 Seeds for consumption.