Decreasing the Cooking Time of the Dry Beans Without Lowering the Quality

Mustafa AKTAŞ[1], İlhan Ceylan[2], Seyfi ŞEVİK[3*], Hikmet DOĞAN[1]

[1] Gazi University, Technology Faculty, Energy Systems Engineering, Teknikokullar, Beşevler, 06500, Ankara, Turkey

[2] Karabük University, Technology Faculty, Energy Systems Engineering, Balıklar kayası, 100.Yıl, Karabük, Turkey

[3*] Karabük University, Vocational School, Balıklar kayası, 100.Yıl, 78050, Karabük, Turkey

(Geliş / Received : 17.04.2014 ; Kabul / Accepted : 15.08.2014)

ABSTRACT

The aim of this study is to decrease the cooking time of the dry beans without lowering the quality. A second soaking was applied to the dry beans after drying, which were cooked for 2 hours following the first cooking. The dry beans were dried at 40 °C drying air temperature after the soaking. The volume of the beans was increased by about 16% through these procedures. Cooking period after the second drying was decreased by 1 hour. Results also showed that there was no split skin on the outer layers of the dry beans, which is a notable quality criterion, owing to the method used while soaking and, soaking and drying operations on the dry beans before packaging decreased the pre-cooking soaking and cooking period. Thus, energy and time saving can be obtained during cooking.

Keywords: Dry bean; Soaking; Cooking time; Drying

Kalitesini Düşürmeden Kuru Fasulye Pişirme Süresinin Azaltılması

ÖZ

Bu çalışmanın amacı, kalitesini düşürmeden kuru fasulye pişirme süresini azaltmaktır. İlk pişirmede 2 saat boyunca pişirilen kuru fasulyeye kurutma işleminden sonra ikinci bir ıslatma uygulanmıştır. Islatma sonrası kuru fasulyeler 40 °C kurutma havası sıcaklığında kurutulmuştur. Fasulye hacmi bu işlemler sayesinde yaklaşık % 16 oranında artmıştır. İkinci kurutma sonrası pişirme periyodu 1 saat azalmıştır. Aynı zamanda sonuçlar; ıslatma sırasında kullanılan yönteme bağlı olarak kayda değer bir kalite kriteri olan kuru fasulyenin dış katmanları üzerinde hiçbir hasarlı cilt olmadığını ve paketleme öncesi kuru fasulye üzerinde ıslatma ve kurutma işlemleri ön pişirme ıslatmasını ve pişirme periyodunu azalttığını göstermiştir. Böylece, zaman ve enerji tasarrufu elde edilebilir.

Anahtar Kelimeler : Kuru fasulye; Islatma; Pişirme süresi; Kurutma

1. INTRODUCTION (GİRİŞ)

As vegetative characters can be variable in the classification of the dry beans, seed characteristics have established the basis for classification. Thus, the classification is made as follows by Sehirali [1]. Beans whose seeds are shaped as a compressed kidney, beans with cylindrical seeds, beans with elliptical seeds and beans with round seeds.

Dry bean is a nutritious food and a perfect source of protein together with the other legume seeds. The cooking time of dry legumes is long. Therefore, dry legumes are waited in water before cooking [2]. Dry beans increase in volume during soaking. Soaking process notably decrease the cooking time. The cooking time of bean among dry legumes change between 1-2 hours, if it has been soaked.

There are studies in the relevant literature on decreasing the cooking time of the dry beans. Dry beans have undergone soaking in water of different properties so as to analyze its effects on the cooking time of the dry beans. The dry beans waited in distilled water are cooked earlier than those awaited in undistilled water [2]. Using a high-performance liquid chromatography (HPLC) method, was analyzed the sugar composition of chick-peas, kidney beans, and lentils in the preparation and cooking process [3]. Dry beans (*Phaseolus vulgaris*) were subjected to soaking, cooking or a combination of both prior to fermentation, and then assessed for oligosaccharides, anti-nutritional factors and in-vitro protein digestibility [4]. The effects of cooking alone and soaking-cooking combination on the oligosaccharide contents of a sugar bean variety that is grown in Turkey was studied by Sat and Keles [5]. Fernandes et al. [6] investigated influence of soaking on the nutritional quality of common beans cooked with or without the soaking water. They noted that there was a greater advantage to discarding the soaking water before cooking.

There are studies in the relevant literature on soaking of different products. Gunasekaran [7] examined the effects of high-pressure application on subsequent

** Sorumlu Yazar (Corresponding Author)*
e-posta: seyfisevik@karabuk.edu.tr
Digital Object Identifier (DOI) : 10.2339/2015.18.1, 29-34

atmospheric soaking of corn. Lu et al. [8] studied absorption of water in long-grain rice rough during soaking. Soaking tests were conducted to determine the rate of water absorption in rice ranging from 14 to 30% initial moisture content (dry basis) at 11, 20, 30, 40 and 50 °C. Fukunaga et al. [9] investigated effects of soaking conditions on the texture of dried sea cucumber. Bayram et al. [10] studied water absorption, leaching and color changes during the soaking for production of soy-bulgur. During the soaking, redness and yellowness index of soybean decreased whereas, moisture content, lightness and yellowness increased. Celen et al. [11] investigated water absorption characteristics of apricot kernels using Peleg's model between temperatures of 20 and 50 °C. Wambura et al. [12] investigated soaking and gelatinization for rough rice parboiling. They reported that ultrasound reduced some 70% of soaking time. Effect of drying temperature and soaking conditions on wet-milling characteristics of amaranth grain was investigated by Calzetta Resio et al. [13]. They stated that the optimum conditions required to maximize starch together with the minimization of protein content in starch fraction included drying temperature of 40 °C with amaranth soaking using 0.05 w/v % of SO_2.

This study aims to prevent the quality decrease which occurs due to split skin during soaking and to decrease the cooking time. As the method application will take place before packaging of the product, the operations to be followed will not change but there will be notable time saving in cooking time.

2. MATERIAL AND METHODS (METARYAL VE METOD)

2.1. Soaking Of Dry Beans (Kuru Fasulye Islatma)

Soaking is important for cooking of legumes because it softens and reduces cooking time. Also it makes easier to digest by breaking down sugars. During the soaking process beans will rehydrate to double or to triple their dry size. A longer soaking time up to four hours is recommended for a good soaking.

There are three soak methods; hot-dip, traditional and quick. Soaking methods are described as the following according to Wehmeier [14]. These methods have some advantages and disadvantages. The traditional soak (long soak) is the most common method used to soak of beans and the complex sugar can be removed by up to 60%. The hot-dip soak is the suggested method that it reduces gas-producing compounds and cooking time but it is long term process. The quick soak method is short term process that can be reduced 80% of complex bean sugars. For traditional soak; firstly, pour cold water over the beans to cover. Than soak beans for 8 hours or overnight. For quick soak; firstly, place beans in a large pot and add 6 cups of water for every 2 cups of beans. Than bring to boil and boil for an additional 2 to 3 minutes. Remove beans from heat, cover and let stand for 1 hour. For hot soak; firstly, place beans in a large pot and add 10 cups of water for every 2 cups of beans. Heat to boiling and boil for an additional 2 to 3 minutes. Remove beans from heat, cover and let stand for 4 to 24 hours. At the end of each method, rinse beans with fresh, cool water. Then, drain beans and discard soak water (cold water starts the rehydration process slowly so beans will appear wrinkled after soaking). As last, rinse beans with fresh, cool water.

Each method varies in terms of time and difficulty. However, each method has its own advantages among them. Hot-dip method is the recommended method for to reduce cooking time and gas-producing compounds.

2.2. Dryer and Drying Conditions (Kurutucu ve Kurutma Şartları)

Dryer in which the drying procedure took place after soaking was shown in Fig. 1. Drying air temperature was tried to be kept the same through computer-controlled adjustable dampers.

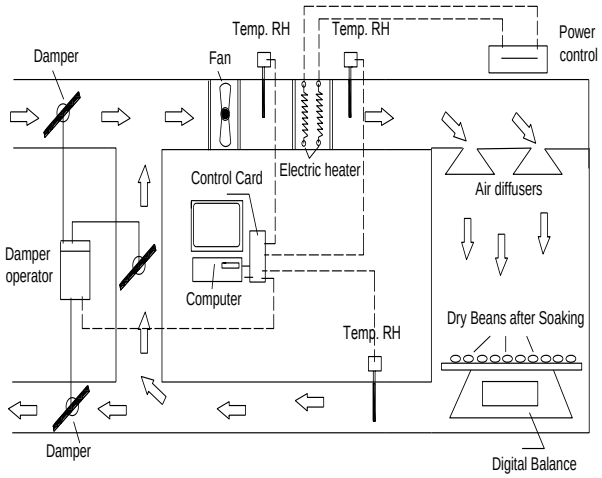


Figure 1. Drying system (Kurutma sistemi)

The water activity (a_w) of any food is an important factor, which has an effective role on losing its quality, by breaking down in the microbiological and chemical-biochemical ways [15]. The activities of some oxygenic molds and the required minimum water activity values for toxin production are shown in Table 1. "Hygroscopic Balance" is achieved when the humidity in the foods is in balance with the relative humidity of the ambient they are located in [16]. When the moisture content in the foods reach a balance with the ambient air relative humidity, then by dividing the ambient air relative humidity with 100, the water activity (a_w) of the moisture content in the foods may be calculated and they may be shown in Eq. 1.

$$a_w = \frac{ARH}{100} \quad (1)$$

The moisture content (dry basis) of the dry bean was calculated from the Eq. 2 [17].

$$MC_{db} = \frac{W_i - W_d}{W_d} \quad (2)$$

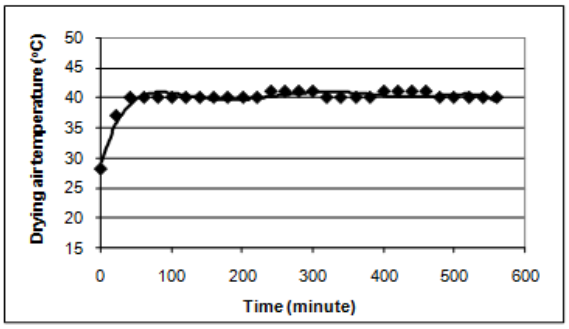
Table 1. The activities of some toxigenic molds and the required minimum water activity (a_W) values for toxin production (Toksin üretimi için gerekli minimum a_W değerleri ve bazı toksijenik küflerin aktiviteleri) [18]

Microtoxins produced	Molds	Minimum water activity values	
		For activity	For toxin production
Aphlatoxin	Aspergillus flavus	0.82	0.83-0.87
	A. parasiticus	0.82	0.87
Ochratoxin	A.ochraceus	0.77	0.85
	Penicillium cyclopium	0.82-0.85	0.87-0.90
Patuline	P.expansum	0.81	0.99
	P.patulum	0.81	0.95
Stachybotryn	Stachybotrys altra	0.94	0.94

The change in water activity of the beans during drying was measured by digital instrument with Testo brand which has measurement accuracy of 0.001 at the value of 0 and +1 a_w. Change in mass of the beans during drying was measured with the digital balance of 6.1 kg Metler Toledo brand with the measurement accuracy of ±0.01 g.

3. RESULTS AND DISCUSSION (BULGULAR VE TARTIŞMA)

Dry beans whose seeds are shaped as a compressed kidney type were waited in undistilled water for 40 hours under 10 °C in refrigerator (200 ppm). In this way, outer skin is puckered under the effect of the water and is tightened to the dry beans, thus failed to come to the water surface. This puckering was eliminated as dry beans absorbed water in time. The width, length and thickness of the 9 sample dry beans which were taken from those to be waited in cold water were measured and marked. The change in size of the selected samples was determined at the end of 40 hours. Mean cooking time of 100 g of the other dry beans than the samples was 2 hours in water at 80 °C. The remaining 190 g dry beans including the samples were dried for 8 hours at 40 °C, 20% relative humidity and 0.3 m s^{-1} of air velocity. Drying air temperature changed between 40 °C and 41 °C and relative humidity changed between 18% and 44%. The change in drying air temperature in accordance with time has been shown in Fig. 2 (a). Relative humidity change of the drying air in accordance with moisture content has been shown in Fig. 2 (b). Moisture content of the dry beans during the drying in accordance with time after soaking was shown in Fig. 3.



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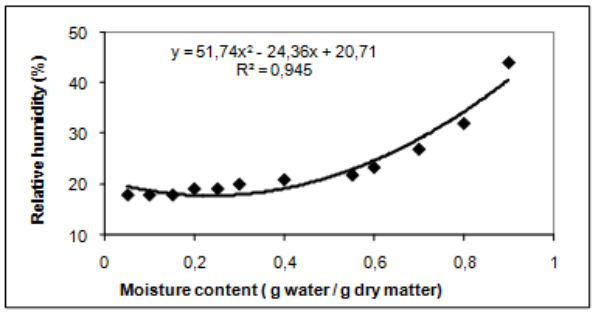


(b)

Figure 2. Graph of change in drying air temperature in accordance with time (a) and change in relative humidity due to the drying (b) (Zamana göre kurutma havası sıcaklığında değişim grafiği (a) ve kurutma nedeniyle bağıl nemdeki değişim grafiği (b))

Table 2. The change in beans in terms of width, thickness and length before and after soaking and after drying (Kurutma sonrası, ıslatma öncesi ve sonrası genişlik, kalınlık ve uzunluğu bakımından fasulyelerde değişim)

	Sizes before soaking			Sizes after soaking			Sizes after drying		
No	L	W	T	L	W	T	L	W	T
1	13.5	7.5	6	15.5	10	8.5	13.5	7.5	7
2	14	8	6	15.5	9	8	14	8	6.5
3	12.5	7	6	15	9	8	13	7	6.5
4	13	8	6	16	10	8.5	13.5	8	7
5	13.5	7.5	5	16	9.5	8	13.5	7.5	6
6	10.5	7.5	6.5	15	9	8	12	7.5	6
7	125	8	5.5	15	10	8	13	8	6
8	125	7.5	6	15.5	9.5	7.5	13.5	8	6.5
9	13	8	5	15.5	9	7	13	8	6

(L: Length, W: Width, T: Thickness)

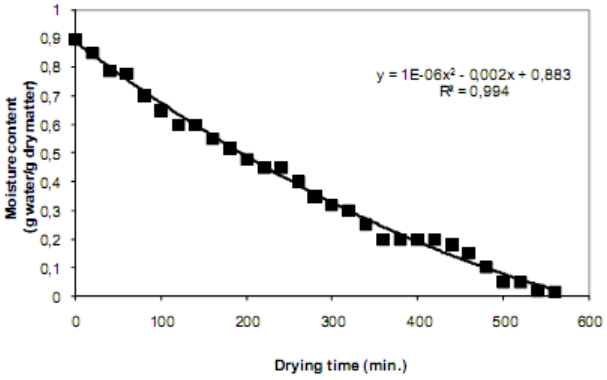


Figure 3. Moisture content of the dry beans during the drying in accordance with time after soaking (Islatılmış kuru fasulyenin kurutma sırasında zamana göre nem içeriği)

The change in size of the samples which were marked was re-measured after drying. The change in beans in terms of width, thickness and length before and after soaking and after drying the 9 sample dry beans was shown in Fig. 4 and Table 1. As shown in Table 1 and Fig. 4, the width and length of the beans after drying is the same as that in the beginning. However, there is an increase in the thickness of the skin. This increase results in an increase in the volume of the beans of about 16%.

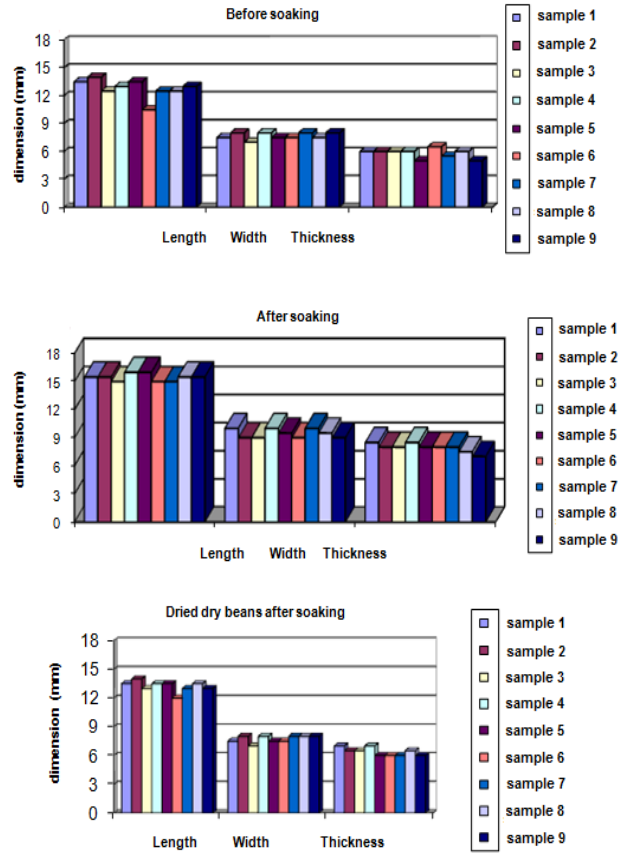


Figure 4. Dimensions of the dry beans; before soaking, after soaking and dried dry beans after soaking (Kuru fasulyenin boyutları; ıslatma öncesi, ıslatma sonrası ve ıslatma sonrası kurutulmuş kuru fasulye)

The changing graph of the water activity of the bean at 20 °C in accordance with the drying ratio of the beans was shown in Fig. 5.

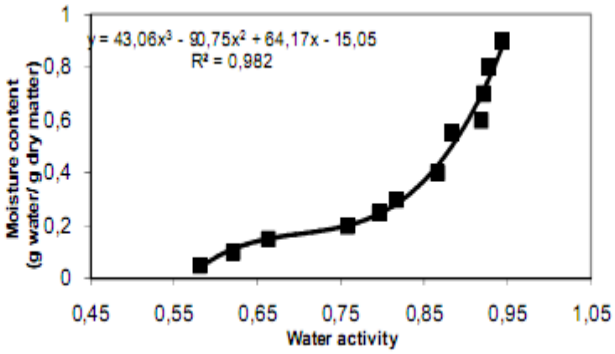


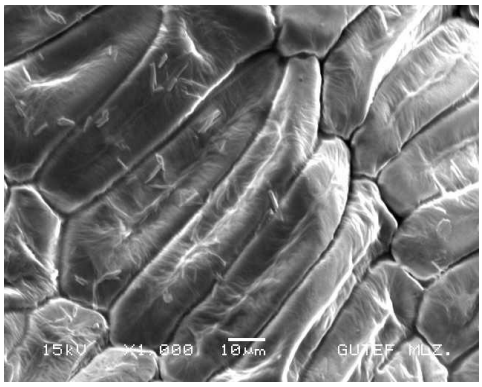
Figure 5. Water activity and moisture content values of the beans dried during soaking (Islatma sırasında kurutulmuş fasulyelerin su aktivitesi ve nem içeriği değerleri)

50 g of beans were taken from the beans which achieved 0.05% moisture content and cooked. Cooking took place at the same cooking water temperature at about 80 °C and took 1.15 hours. However, outer skin rapidly grew due to the temperature and there was split skin. Therefore, outer skin came to the surface due to this split skin while cooking. Beans which were dried after soaking were re-soaked for 24 hours at the water at 10 °C. In the mean time outer skin quickly absorbed the water which caused them to enlarge more than the inner part. Despite there was a relatively much higher enlargement in outer part when compared to inner in the beginning of the soaking, this has no longer been the case after soaking due to the enlargement in inner part because of moisture intake. Soaked dried beans were cooked for 1 hour in the same cooking temperature at about 80 °C. There was no split skin of the beans which had sufficient size during cooking. Cooking time of the beans at different conditions is shown in Table 3.

Table 3. Experiment results obtained after various operations the dried beans have undergone (Kurutulmuş fasulyelerin çeşitli operasyonlardan sonra elde edilen deney sonuçları)

Condition	Cooking time (hour)	Soaking time (hour)	Split skin	
			While cooking	While soaking
Soaked	2	40	No	No
Dried after soaking	1.15	---	Yes	---
Re-soaked after drying	1	24	No	No

This notable decrease in the cooking time stem from the change in the structure of the beans. Therefore, inner structure of the beans was analyzed with Jeol brand Jsm-6060LV model electron microscope. Scanning electron micrographic (SEM) studies of dry beans obtained are shown in Fig. 6. Unprocessed inner structure of the dry beans is shown in Fig. 6 (a, c). Inner structure of the dry beans after soaking is shown in Fig. 6 (b, d).



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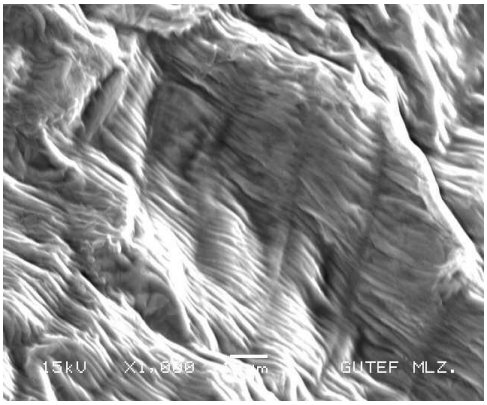

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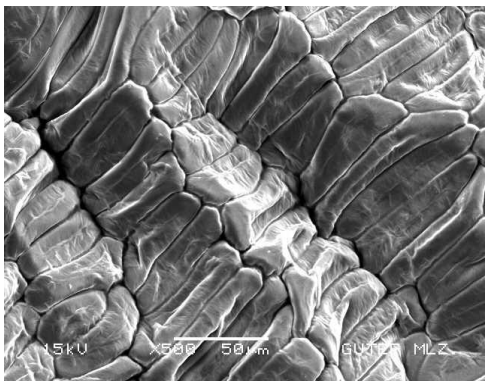

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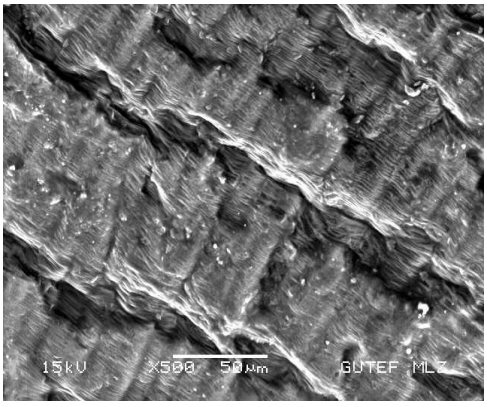

(d)

Figure 6. Unprocessed inner structure of the dry beans (a, c) and inner structure of the dry beans after soaking (b, d) (Kuru fasulye işlenmemiş içyapısı (a, c) ve ıslatma sonrası kuru fasulye içyapısı (b, d))

Effect of different drying conditions on the structure of dried beans was observed under scanning electron microscope. In direct air-dried samples (a, c) there is very less open structure and pores as compared to soaking air-dried samples (b, d), indicating severe tissue shrinkage and collapse during direct air drying. Drying after the soaking of product created a porous structure with very little shrinkage, thereby can be provided better rehydration characteristics.

Dry beans are washed in fresh water after soaking and prepared for cooking. In the method applied, beans were dried and the same operations were carried out. Hard particle structure of the dry beans which were shown in Fig. 6 (a, c) were modified and they were turned into a single structure shown in Fig. 6 (b, d), which is bound with fibres and has a hole within. In this way, soaking and cooking period was diminished.

4. CONCLUSION (SONUÇ)

The method applied to the dry beans in this study should be followed before packaging. In this way, it will be observed that these periods will be decreased when the package is opened and the operations before cooking are repeated (soaking and then cooking). Thus, the decrease in the cooking time of the dry beans will save time and energy. The volume of the beans was increased by about 16% through these procedures. Some food colorings can be made use of so as to avoid possible color change in beans. Technical conditions should be facilitated during re-soaking so as to avoid possible split skins. Minimum water activity value should be reached to prevent the formation of microorganisms and various molds when the beans which were dried after soaking were packed.

Abbreviations and Symbols	
a_w	Water activity
ARH	Ambient relative humidity, %
MC_{db}	Moisture content on dry basis, g water (kg dm)$^{-1}$
W_i	Initial weight, g
W_d	Dried weight, g

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