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EFFECT OF STORAGE TIME ON TEXTURE AND SELECTED PROPERTIES OF WALNUTS

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A b s t r a c t. The aim of this investigation was to determine the effect of storage time on selected properties of walnuts roasted according to different methods. The material for investigation consisted of halves of shelled walnuts roasted in hot oil (140^{o}C/5 min.) and hot air (160^{o}C/15 min.). The control samples were raw walnuts not subjected to thermal processing. Portions of walnuts, of 200 g mass, were vacuum packed in aluminium foil bags and stored in standard conditions for 5 months. In the samples, before storing and after each month of storage, the following parameters were determined: moisture content, texture – with the use of Instron 5544 apparatus, colour – using Minolta CR-200 colorimeter, as well as organoleptic features: colour, taste, flavour and texture according to 5-point scale (1-5 points). It was found that roasted walnuts were characterized by darker colour, lower moisture content and mechanical strength in comparison with raw walnuts. When in storage, there took place a slight increase in roasted walnuts moisture content and an insignificant decrease in raw walnuts moisture content. In the subsequent months of storage there could be recorded an increase in walnuts bending strength, while their compressive strength remained the same. The results of bending test were correlated with sensory assessment of nut texture. That double testing proved a loss of walnut crispness and an increase in their hardness. Roasting, especially that conducted in oil, caused worsening of walnut sensory properties in the course of storage. Disadvantageous alterations involved, first of all, increased hardness, as well as less favourable walnut taste and flavour.

K e y w o r d s: walnuts, roasting, storage, texture, colour, sensory assessment

INTRODUCTION

Roasting is one of the most frequently applied forms of thermal processing of walnuts which leads to alterations in their sensory properties. When subjected to roasting, walnuts obtain characteristic colour, favourable taste and flavour, as well

as delicate and crispy texture (Özdemir and Devres 1999, Özdemir *et al.* 1999). Roasting also ensures microbiological safety, as high temperature of the process causes deactivation of possible toxins or allergens present in walnuts (Demir *et al.* 2003). The only disadvantage of roasting is disturbance of walnut cell structure which facilitates oxygen and steam diffusion (Kubara and Dębski 2005). This factor plays a considerable role in products which, after roasting, are stored both in their natural form and as a component of different products. Raw nuts can be stored for several months without any significant worsening of their sensory properties (Zdyb 2003), yet due to roasting their storage time becomes shorter (Sze-Tao *at al.* 2001). In the course of storing, nuts are first of all exposed to moisture content changes which effect nut texture, taste and flavour, as well as to alterations in fat they contain (about 65%), connected mainly with oxidation, which directly influences their taste and flavour (Savage *at al.* 1999). The most characteristic quality feature of roasted nuts is their crispy and delicate texture (Saklar *at al.* 2003). Therefore, the subject of this work was determination of the effect of roasting by different methods on walnut texture during their storage. The examinations also involved the degree of worsening of other quality parameters of stored walnuts.

MATERIALS AND METHODS

The material used for investigation were shelled halves of walnuts originating from Poland. The nuts were subjected to roasting according to two methods – in hot oil (in a roaster of 4 dm^3 capacity) and in hot air (in a laboratory drier). Roasting in oil (refined rape oil was applied) was carried out at the temperature of 140^{o}C for 5 min., while in the air – at 160^{o}C for 15 min. The nuts obtained with both methods featured similar physicochemical as well as sensory properties. 200 g roasted nuts portions, cooled to room temperature, and raw walnuts (not subjected to roasting) were vacuum packed in aluminium foil bags. Nut samples were stored in standard conditions (temperature of 20^{o}C, relative humidity *RH* 30-50%) for 5 months. Determination of the examined parameters in roasted walnuts took place once a month, while in raw walnuts the determinations were done after the third and fifth month of storage. The experiment was conducted in two parallel technological replications.

The following parameters were determined in the walnuts before and during storage: moisture – by drier method, texture – with the use of strength testing machine Instron 5544 equipped with strain gauge head featuring measurement range to 2 kN. Nut halves underwent bending test in three-point support system and compression test between two plates. In both tests strain gauge head was moving at the speed of 5 mm min^{-1} up to the moment at which sample destruction took place. There maximum bending force Fb_{max} and the value of maximum

compressive force Fc_{max} were determined (Kita and Figiel 2006a). Walnut colour was assessed with the use of Minolta CR-200 colorimeter scaled according to Hunter scale of *L**, *a**, *b** units. The measurement was done using a previously ground nut sample. Organoleptic features were determined also according to a 5-point scale of assessment worked out at the Department of Food Storage and Technology of Agriculture University in Wrocław. General sensory assessment included assessment of walnut texture, colour, flavour and taste. The assessment was done by a 5-person group of trained students.

The results obtained in the experiment were subjected to statistical analysis by means of Excel and Statistica 6.0 programs. The method of linear regression and least significant difference LSD were applied to examine the dynamics of moisture content and texture changes in walnuts.

RESULTS AND DISCUSSION

Moisture content of walnuts vacuum packed in aluminium foil bags underwent a slight alteration during 5 months of storage, in spite of hermetic weld (Fig. 1).

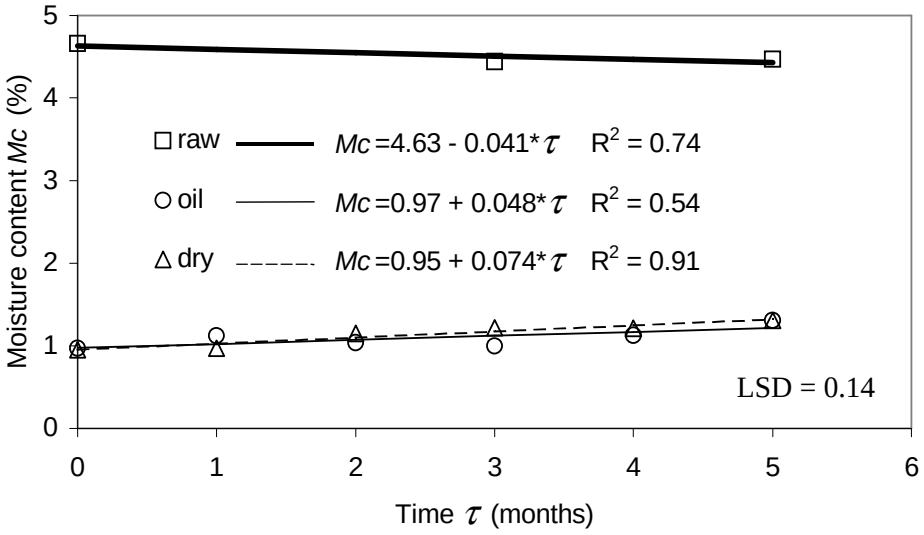

Fig. 1. Moisture content changes of raw and roasted walnuts in storage (LSD - least significant deference refers to roasted walnuts)

Raw walnuts moisture content decreased from 4.6 to 4.4%, while that of roasted walnuts, both by oil and air methods, increased from 1.0 to 1.3%. It was possible due to the fact that the foil used for the bags was not completely permeable to

water vapour (Adeyemi *at al.* 2002). Pressure of vapour released from raw nuts with water activity of 0.53 was high enough to permeate outside, where its pressure was lower at *RH* 30–50%. Consequently, a decrease in raw nuts moisture content took place. Low moisture of roasted walnuts with water activity of 0.07 was accompanied by low water vapour pressure. Due to this fact infiltration of vapour featuring higher pressure from outside into a bag was possible and the result was walnut wetting (Fig. 2).

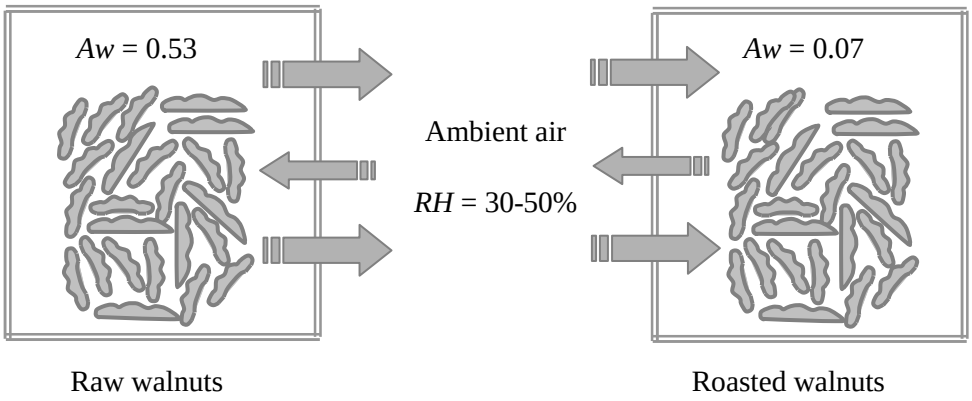

Fig. 2. Water vapour exchange between ambient air and walnuts packed in plastic bags

On the basis of strength tests it was determined that raw walnuts featured higher bending and compression strength than roasted walnuts (Figures 3 and 4). That was connected with higher moisture content of raw nuts. The results of numerous examinations prove that decrease in walnut moisture content caused a decrease in their mechanical strength (Aydin 2002, Demir and Cronin 2004, Saklar *at al.* 1999). Both oil and air roasting at optimum parameter values was to ensure the best quality of samples for storing. Due to this fact walnuts roasted in oil and air were characterized by similar moisture content (Fig. 1). It is worth noting that during storage compressive strength of walnuts roasted in oil was lower than that of walnuts roasted in hot air. However, bending strength of walnuts was similar irrespective of the method of roasting. As it turned out, in the course of storage the bending strength of walnuts increased (Fig. 3), while their compression strength was not undoubtedly altered (Fig. 4). It should be noticed that during bending there occurred cracking of homogenous material in a direction lateral to the plane of adhesion of cotyledons forming a nut half, while when under compression, separation of cotyledons took place along that plane.

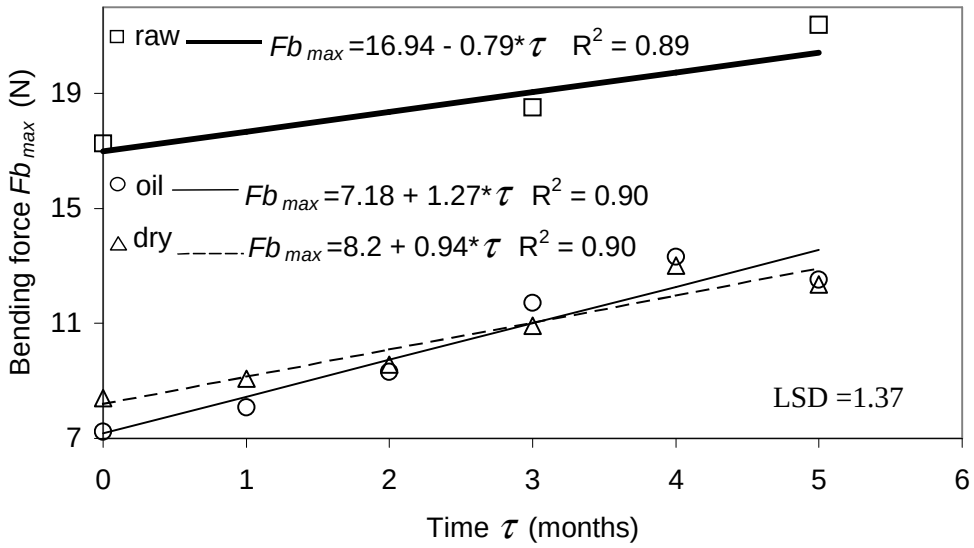

Fig.3. Effect of storage time on maximum bending force of raw and roasted walnuts (LSD - least significant deference refers to roasted walnuts)

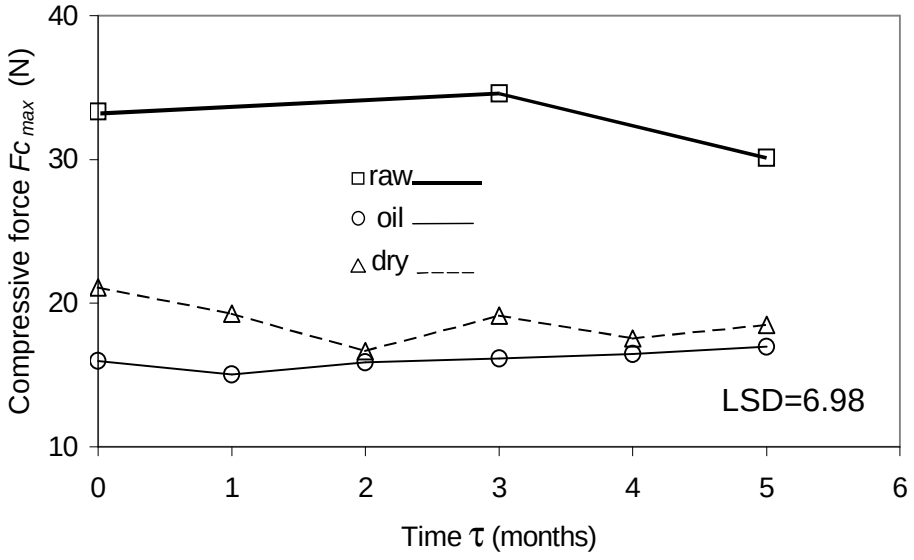

Fig. 4. Effect of storage time on maximum compressive force of raw and roasted walnuts (LSD - least significant deference refers to roasted walnuts)

The results of sensory test (Fig. 5) indicate a decrease in nut crispness while storing and they prove that persons assessing nut texture have the impression of increased sample hardness when it cracks.

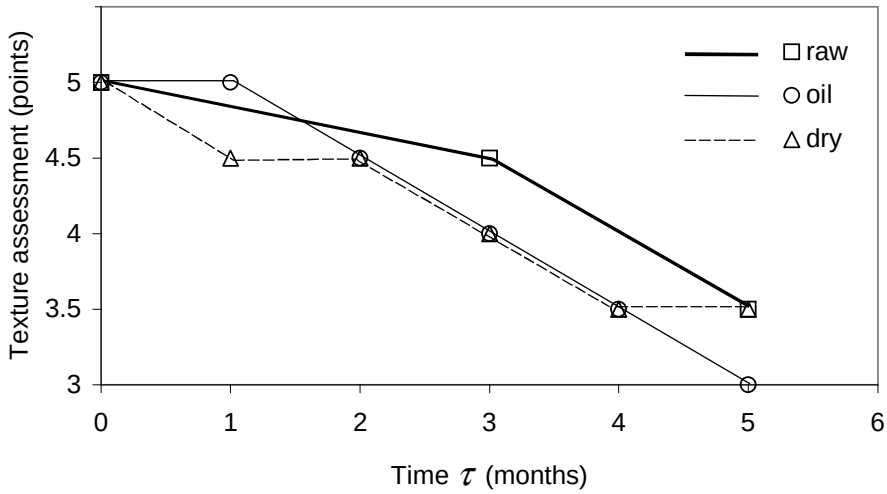

Fig. 5. Effect of storage time on texture sensory assessment of raw and roasted walnuts

Therefore, the results of bending test, as compared to the results of compression test, are more correlated with the results of texture sensory assessment (Fig. 6). The force cracking raw nuts increased in the course of storage from 17 to 21N, i.e. by about 25% (Fig. 3). The increase in raw nuts bending strength should be associated exclusively with the effect of storage time itself, when an increase in their hardness took place. It should be taken into account that during storage there occurred a slight decrease in nut moisture content (Fig. 1) which facilitates the decrease in their hardness. On the other hand, the force breaking roasted nuts increased from about 8 to about 12 N, i.e. by 50% (Fig. 3). Higher values of roasted walnut strength can be connected not only with storage time itself, but also with a certain increase in their moisture content (Fig. 1). As far as roasted nuts are concerned, their moisture content is usually very low and even a small change significantly affects nut strength properties (Demir and Cronin 2004, Perren and Escher 1997). Figure 6 shows the effect of stored walnut moisture content on the texture assessment. Increase in the moisture content of roasted walnuts resulted in a decrease of texture assessment. Then again, increase in the moisture content of raw walnuts increased their texture assessment. However, the increase in moisture content of raw walnuts was associated with shortening of storage time and with reduction of bending force as well (Fig. 3). The reduction of bending force favoured the texture sensory assessment of walnuts (Fig. 7).

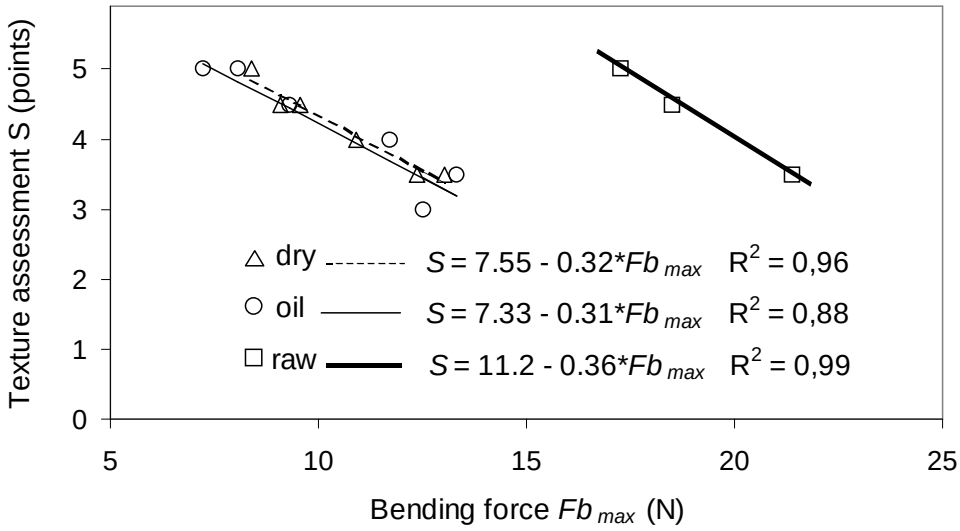

Fig. 6. Correlation between texture sensory assessment and maximum bending force of raw and roasted walnuts

Walnut roasting caused a decrease in *L* parameter values, which is connected with walnut colour getting darker, and there took place an increase in *a* and *b* parameter values, connected with getting brown (Tab. 1). It particularly involved walnuts roasted in oil. Instrumental assessment indicated that in the case of raw nuts there took place an increase in *b* parameter value, while in the case of roasted nuts (both oil and air roasting) also an increase in *a* parameter value was recorded. The value of *L* parameter determined for raw nuts remained at the same level, while for roasted nuts its increase was observed.

Table 1. Colour evaluation of raw and roasted walnuts before and after storage

Colour parameter	*L*			*a*			*b*		
Method	raw	oil	dry	raw	oil	dry	raw	oil	dry
Before storage	60.6	49.5	53.3	0.85	4.3	3.1	17.1	23.4	22.4
After storage	60.5	51.8	55.2	0.66	5.0	3.2	18.7	25.6	22.7

In the course of storing there also took place a worsening of general sensory assessment of the stored nuts (Fig. 8). The lowest value of sensory assessment given to oil roasted walnuts can result from the dynamics of chemical alterations

taking place in fat contained in nuts. Oil roasted nuts were characterized by several percent higher fat content in comparison to the remaining samples, which was connected with adsorption of roasting oil. Therefore hydrolytic and oxidation alterations took place in nuts roasted in oil (Kita and Figiel, 2006b), directly affecting the taste and flavour of stored samples.

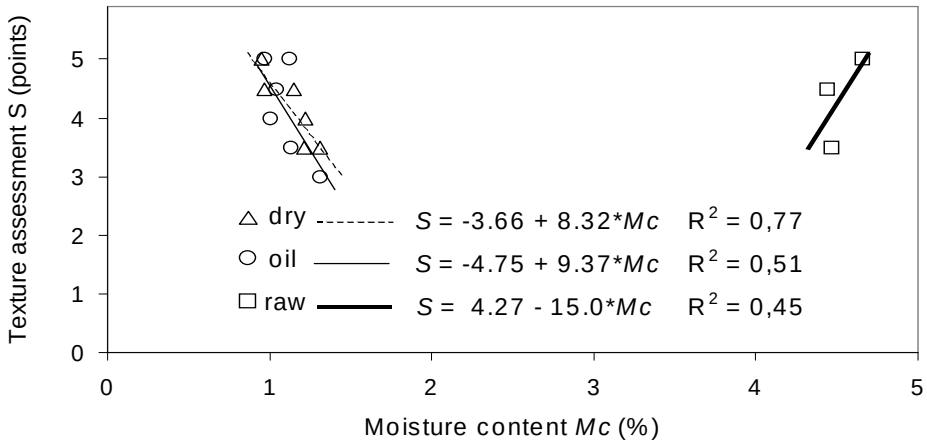

Fig. 7. Effect of stored walnuts moisture content on texture sensory assessment

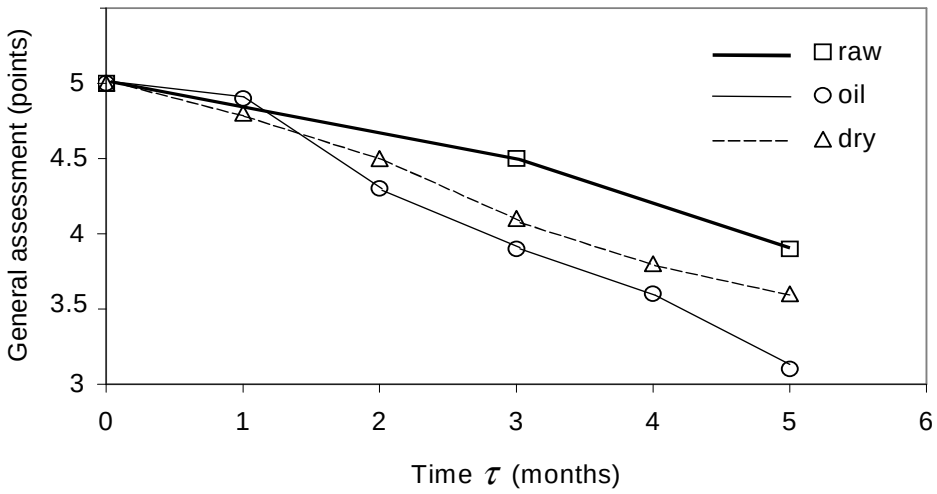

Fig. 8. Effect of storage time on general assessment of raw and roasted walnuts

CONCLUSIONS

1. Roasted walnuts featured darker colour, lower moisture content and mechanical strength as compared to raw nuts.

2. Moisture content of vacuum packed walnuts slightly changed in the course of storage. At the same time roasted nuts moisture content increased and raw nuts moisture content decreased.

3. Compressive strength of stored walnuts roasted in oil was lower than that of stored walnuts roasted in hot air. However, bending strength of stored walnuts was similar irrespective of the method of roasting.

4. In the successive months of storage walnuts bending strength increased, while their compression strength did not show any change. Increase in bending force decreased the texture sensory assessment of walnuts. According to the latter, walnuts were losing their crispness and they became harder.

5. In the course of storage there took place a worsening of walnuts sensory properties. Sensory assessment of walnuts roasted in oil was lower compared to that of walnuts roasted in hot air.

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WPŁYW CZASU PRZECHOWYWANIA NA TEKSTURĘ I WYBRANE WŁAŚCIWOŚCI ORZECHÓW WŁOSKICH

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S t r e s z c z e n i e. Celem przeprowadzonych badań było wyznaczenie wpływu czasu przechowywania na wybrane właściwości orzechów włoskich prażonych różnymi metodami. Materiałem użytym do badań były połówki łuskanych orzechów włoskich prażone w gorącym oleju (140°C/5 min) oraz w gorącym powietrzu (160°C/15 min). Próbę kontrolną stanowiły orzechy surowe nie poddawane obróbce termicznej. Porcje orzechów o masie 200 g zapakowane próżniowo w woreczkach z folii aluminiowej przechowywano w warunkach standardowych przez 5 miesięcy. W próbach przed przechowywaniem oraz po każdym miesiącu przechowywania oznaczano: wilgotność, konsystencję – przy użyciu aparatu typu Instron 5544, barwę – przy użyciu kolorymetru Minolta CR-200 oraz cechy organoleptyczne: barwę, smak, zapach i konsystencję – według skali punktowej (1-5 pkt.) Stwierdzono, że orzechy prażone charakteryzowały się ciemniejszą barwą, niższą wilgotnością oraz wytrzymałością mechaniczną w porównaniu z orzechami surowymi. Podczas przechowywania nastąpiło nieznaczne zwiększenie wilgotności orzechów prażonych i niewielkie zmniejszenie wilgotności orzechów surowych. W kolejnych miesiącach przechowywania wzrastała wytrzymałość orzechów na zginanie, natomiast nie ulegała zmianie ich wytrzymałość na ściskanie. Wyniki testu wytrzymałości na zginanie były skorelowane z oceną sensoryczną konsystencji, w której orzechy traciły chrupkość i stawały się twardsze. Prażenie, szczególnie w oleju, spowodowało pogorszenie właściwości sensorycznych orzechów podczas przechowywania. Niekorzystne zmiany dotyczyły przede wszystkim zwiększenia twardości, a także pogorszenia smaku i zapachu orzechów.

S ł o w a k l u c z o w e: orzechy, prażenie, przechowywanie, tekstura, barwa, ocena sensoryczna