Acta Agrophysica, 2002, 77, 23-32

FACTORS AFFECTING POTATO CHIPS TEXTURE DURING STORAGE

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Summary. The aim of this work was determination of the effect different factors exert on potato chips texture during storage. The material of investigation were potato chips from one of the production plants. The chips which underwent examination originated from the same technological conditions of production and differed in their slice thickness (normal and wavy), the kind of spices applied (cheese-onion, red pepper, salt, bacon) and in the kind of package filling (normal atmosphere and nitrogen). It was stated that during storage chips texture was the subject of several changes – the chips lost their characteristic crispness and were getting harder. Wavy chips sooner showed their increasing hardness than the flat ones. The changes in chips texture were connected with the changes of their water content. When stored in identical humidity of air, chips texture showed different hardness due to the kind of spices used – bacon chips underwent the most dramatic changes, while cheese-onion chips remained the least affected. The way of packaging affected chips moisture during their storage. The chips stored in the atmosphere of nitrogen featured lower moisture and lesser hardness than the ones packed traditionally within the period of 28 weeks of storage.

Keywords: potato chips, storage, texture.

INTRODUCTION

Potato chips are one of the most popular snack products. They have shape of thin potato slices fried in fat or oil and their surface is covered with different kinds of flavors. In Poland chips appeared on the market at the beginning of the 90 s, first as an imported product and then as the one produced at home by local manufacturers, as well as, in the production plants supported by a foreign capital [9].

Main specifications of potato chips quality are: color, fat content, taste, odor and texture, characteristic crispy texture has become one of their essential quality feature and perhaps the most attractive one as far the success on the market is taken into account. The feature depends on the quality of raw material and technological procedure. However, it can undergo certain changes during potato chips storage.

Investigations, which have been carried out so far proved that chips texture is connected with potato dry mass content. The chips produced from potatoes of high dry mass content (more than 25%) may have tough texture, while the chips made of potatoes of too low weight density, which contain a lot of fat, are characterized by greasy, only slightly crispy texture [8,10].

Detailed analysis of the effects of particular potato components showed that chips texture depends mainly on starch content and subsequently, on the sum of non-starch polysaccharides and protein nitrogen. Among the former ones and lignin decisive role in shaping chips texture is played by pectic compounds – protopectins [5]. Besides, significant influence on chips texture can also exert technological parameters such as slice thickness, the kind of blanching, temperature, as well as the time of frying [2,8].

The freshly produced chips possess determined texture, yet that quality undergoes certain changes during the storage. Because of a specific composition of potato chips – very hygroscopic products – the crucial role in shaping their quality is played by water content. It occurs that water affects produced and stored products to a high degree. Adsorption of water from the environment affects chips plasticity, which is connected with the loss of their characteristic crispness. Therefore determination of optimum water content in a product and correlated critical water activity (a_w) has become a very important task. Kaghan determined maximum water content for chips, which should not exceed 3%, while up-to-date norms lowered that limit to 2% [3]. Quast and Karel estimated critical water activity (a_c) for chips as 0.4. The product with higher a_w loses its characteristic crispness and does not meet consument's demands. The loss of crispness takes place mainly due to the changes in carbohydrates fraction [12].

The aim of the present work was to determine the effect of different factors on shaping chips texture during storage.

MATERIALS AND METHODS

The subject of this investigation were potato chips produced in one of the production plants. The chips resulted from the same technological conditions, while their differentiating factors were as follows:

1. potato slice thickness (normal and wavy)
2. the kind of spices used (cheese-onion, red pepper, salt and bacon)
3. the kind of package filling (atmosphere air and nitrogen).

The chips were packed into 100g packages made of thermoweldable aluminium foil and stored under standard conditions for 28 weeks. Analyses were performed every two weeks and 3 packages out of each sort of chips served as a subject. Their content was mixed in order to obtain unified investigation material. Analysis involved: determination of moisture – according to gravimetric method [6], water activity – with the use of Thermoconstater Novasin apparatus RDT-30 TH1, fat content – Soxhlet method [6], texture – instrumental method with the use of Stevens QTS-25 apparatus, compatible with CP/At computer with Steven's software (the force needed for cutting chips was measured with the use of a rectangular cutting attachment. To all measurements a crosshead speed of 250 mm/min. was applied. The measurement of the texture was performed in 30 laboratory repetitions for each sample), and organoleptic method based on 5-point scale (5 points-the best, 1 point-the worst) presented by the Department of Food Technology and Storage at Agricultural University of Wrocław [7].

The method of non-linear regression (Marquart procedure) [1] was applied to examine dynamics of chips texture changes in chips with different spices.

RESULTS AND DISCUSSION

Figure 1 presents the changes of moisture in the chips produced with two different slice thickness and stored for 28 weeks. Immediately after their production and in the first weeks of storage the chips had the same moisture. After the 16^{th} weeks of storage it could be stated rapid increase of moisture in wavy chips when compared to the flat ones. Analysis performed with the use of Stevens QTS-25 apparatus (Fig. 2) proved that chips differed in hardness immediately after their production: wavy chips presented higher hardness than the flat ones. When stored, both kinds of chips showed an increasing hardness, though wavy chips, especially at the end of their storage period, were getting hard more rapidly.

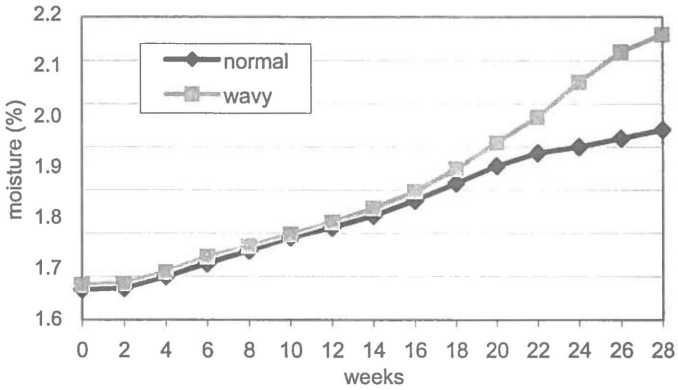

Fig. 1. Changes of moisture content in chips normal and wavy during 28 weeks of storage.

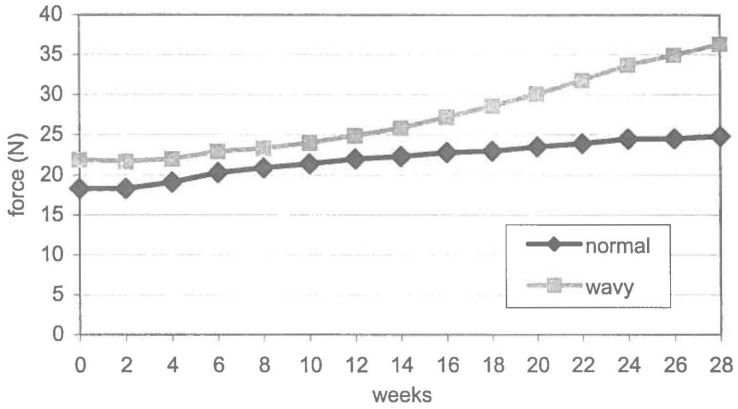

Fig. 2. Changes of texture in chips normal and wavy during 28 weks of storage.

Gamble and Rice [2] investigated the influence of potato slice thickness on their water content. They stated that in the process of frying thin potato slices lose water faster than the thicker ones. Due to that fact thin potato slices, even fried for a short time, featured humidity lower than 1%. After reaching certain critical slice thickness, however, water content depended both on slice thickness and the time of frying.

Chips crispness is directly related to their moisture. As water content increases gradual loss of crispness takes place and their hardness increases. The chips stored showed appropriate crispness immediately after their production. During the storage period the chips were subsequently becoming harder –

instrumental measurement and they sensory quality was lower and lower.

The chips differ in the kind of used spices. The changes of chips humidity for chips with different spices during their storage for 28 weeks is presented on Fig. 3. All kinds of chips showed low, appropriate moisture < 1.6% immediately after their production. When stored, chips displayed slight increase of moisture, but sooner than 24 weeks did it exceed 2% (only in cheese-onion chips). The changes in chips texture are presented on Fig. 4. Hardness of all kinds of chips increased evenly, yet the hardest ones proved to be red pepper chips.

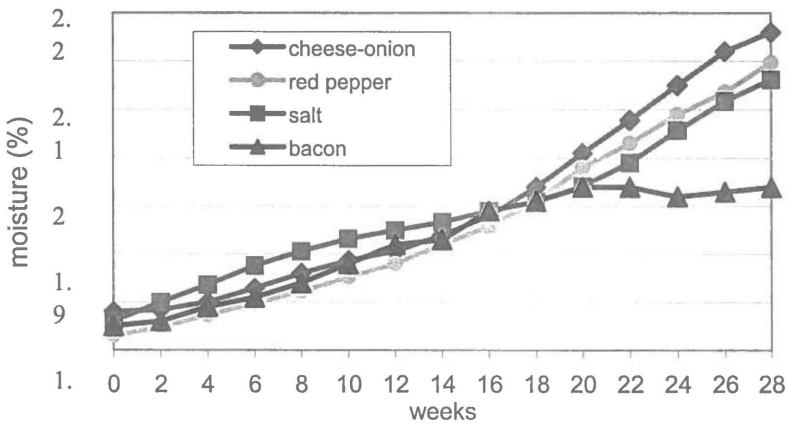

Fig. 3. Changes of moisture in chips with different spices during 28 weeks of storage.

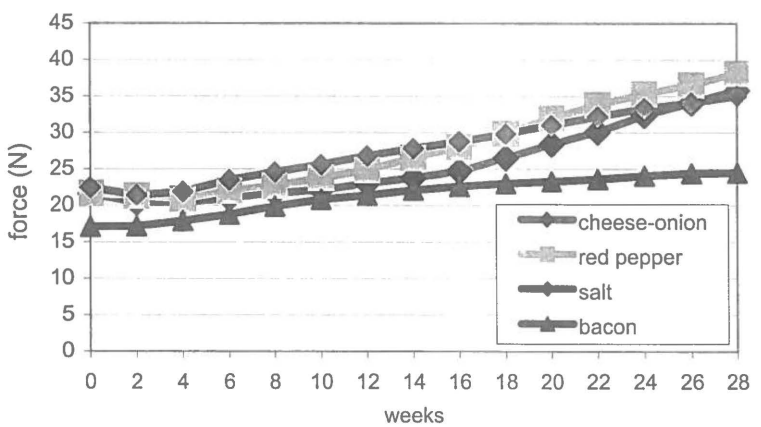

Fig. 4. Changes of texture of chips with different spices during 28 weeks of storage.

Crispness of low water content products significantly depends on chips humidity. Fig. 5 shows the changes in chips texture in relation to their humidity. The most rapid increase of hardness displayed bacon chips.

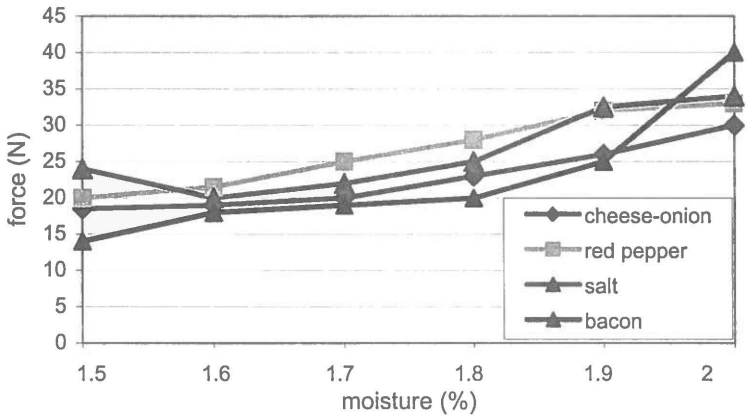

Fig. 5. Changes of chips texture depending on moisture.

Figures 6 and 7 present the changes in water activity values for the stored chips in relation to potato slice thickness and the kind of spice used. Analysis proved that water activity value immediately after chips production was 0.066 – wavy chips and 0.070 – flat ones. Slight increase of a_w could be recorded no sooner that after 21 weeks of storage. In the case of flavored chips a bit higher water activity showed salt chips when compared to the remaining kinds of chips.

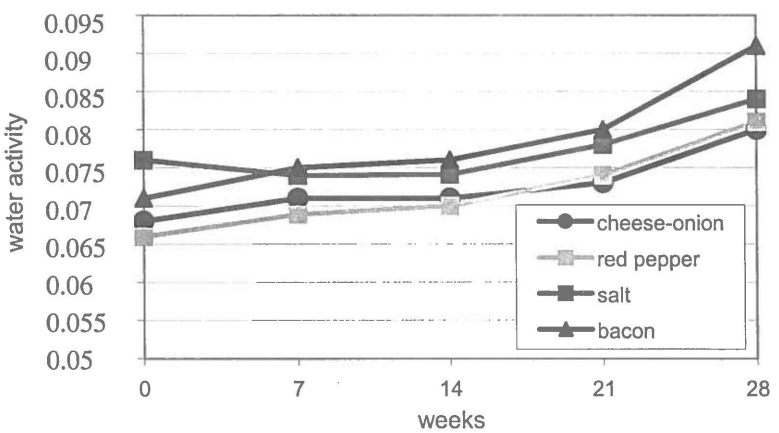

Fig. 6. Changes of water activity in chips with different spices during 28 weeks of storage.

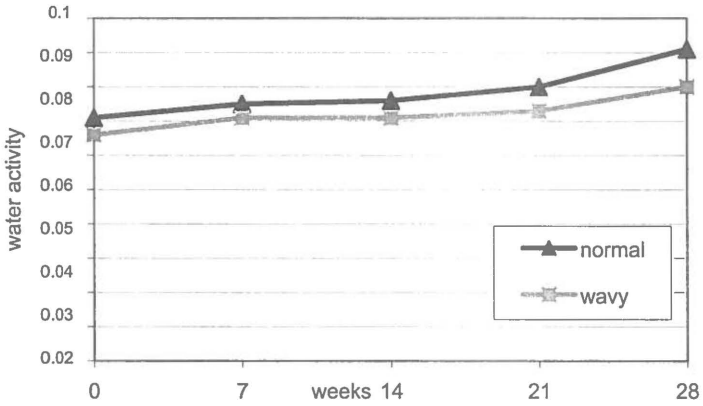

Fig. 7. Changes of water activity in chips normal and wavy during 28 weeks of storage.

Katz and Labuza [4] estimated chips crispness in relation to a_w value. The chips of a_w<0.11 were described as very crispy. As a_w value increased and when a_w equaled 0.52 the chips were no longer crispy. The authors mentioned above found relation between a_w value and chips crispness assessed organolepticaly to be inversely proportional.

Quality of stored products depends markedly on the conditions of storage. Fig. 8 presents the changes of moisture in the chips packed traditionally and those kept in the atmosphere of nitrogen for 28 weeks. When produced, the chips moisture increased and it was slightly higher for the chips packed traditionally.

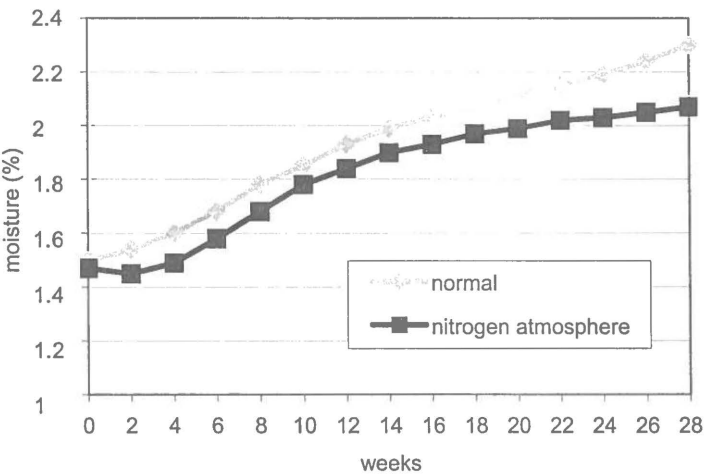

Fig. 8. Changes of moisture content in chips packed in normal and nitrogen atmosphere during 28 weeks of storage.

The changes in chips texture are shown on Fig. 9. Immediately after their production, the chips featured appropriate crispness and hardness – 18N. Until the 16th week of storage chips hardness did not change and then it started to increase. More rapid increase of hardness displayed the chips packed traditionally (35N after 28-week-storage) than the chips packed in the atmosphere of nitrogen.

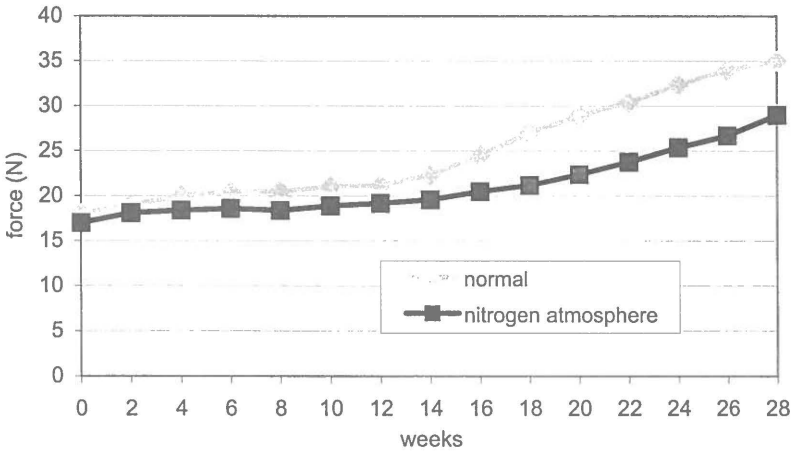

Fig. 9. Changes of texture in chips packed in normal and nitrogen atmosphere.

CONCLUSIONS

1. Chips texture underwent several changes during storage – the chips were loosing their characteristic crispness and became harder. Wavy chips showed more rapid increase of hardness than the flat ones. The changes in chips texture during their storage were connected with the changes in their water content.
2. When stored under conditions of the same moisture, chips texture was effected by the kind of spices used – bacon chips presented the faster growth of their hardness, while the slowest one showed cheese-onion chips.
3. The way of packaging affected the changes of chips moisture in the conditions of storage. The chips packed in the atmosphere of nitrogen featured lower moisture and lower hardness in comparison to the chips packed traditionally, both stored for 28 weeks.

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CZYNNIKI WPŁYWAJĄCE NA KONSYSTENCJĘ CZIPSÓW ZIEMNIACZANYCH PODCZAS PRZECHOWYWANIA

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Streszczenie. Celem niniejszej pracy było określenie wpływu różnych czynników na kształtowanie konsystencji czipsów podczas przechowywania. Materiałem do badań były czipsy ziemniaczane wyprodukowane w jednym z zakładów produkcyjnych. Czipsy użyte do badań produkowane były w tych samych warunkach technologicznych, a czynnikami różnicującymi były: grubość plasterków ziemniaka (normalne i faliste), rodzaj użytej przyprawy (serowo-cebulowe, paprykowe, solone i bekonowe), rodzaj wypełnienia opakowania (atmosfera normalna i azotu).

Stwierdzono, że konsystencja czipsów podczas przechowywania zmieniała się - czipsy traciły charakterystyczną kruchość i stawały się coraz twardsze. Szybciej wzrastała twardość czipsów falistych niż czipsów płaskich. Zmiany konsystencji czipsów w czasie przechowywania związane były ze zmianami zawartości wody w czipsach. Przy identycznej wilgotności czipsów wpływ na kształtowanie konsystencji odgrywa rodzaj stosowanej przyprawy – najbardziej wzrastała twardość czipsów bekonowych, a najmniej z dodatkiem przyprawy serowo-cebulowej.Sposób pakowania czipsów wpływał na zmiany wilgotności czipsów podczas przechowywania. Czipsy pakowane w atmosferze azotu charakteryzowały się niższą wilgotnością i zarazem były mniej twarde w porównaniu z czipsami pakowanymi tradycyjnie podczas 28 tygodni przechowywania.

Słowa kluczowe: czipsy ziemniaczane, przechowywanie, konsystencja.