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INFLUENCE OF PELLETS MOISTURE AND DIETARY FIBRE ADDITION ON SOME POTATO SNACKS PROPERTIES

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Summary. The sensory properties, consistency and surface structure of snacks obtained with the addition of 5 and 10% of dietary fibre, after frying of pellets with different moisture content were determined. Studied properties of snacks depended on the pellets moisture as well as on the quantity of added dietary fibre. Along with the increasing the amount of moisture content in pellets from 10 to 18%, both without and with 5% of fibre addition, obtained snacks possessed the similar proper quality. The correlation found between the moisture content in pellets with different level of dietary fibre addition and the consistency of obtained snacks is described by the equation $y = a + bx + cx^2$. Results obtained in the performed experiments allow to believe that the proper moisture content in pellets is placed in a proportionally wide range from 12 to 16%, also with the fibre additive but not higher than 5%.

Keywords: pellets, moisture, dietary fibre, snacks quality.

INTRODUCTION

Snacks are crispy products which find consumers in many countries of the world. Some of them are produced as a direct extrusion products and another one as fried snack pellets. Pellets are semi products obtained in cold extrusion process and dried up to about 11-12% of moisture. They are small, light products with glass-like surface and has a long shelf life. Dipped in hot oil for 6-10 seconds expand in size about 3-5 times [2,4,9,11,12,15,16]. Obtained snacks are ready to eat without flavourings. They are characterized by variety of shapes and tastes, porous texture and crispy consistency with different level of hardness, dependent

on raw material properties as well as on extrusion parameters and drying process conditions [2,4,6,12,13,15]. The quality of snacks is closely related to the pellets properties. The most important are: moisture, the content of gelatinized and ungelatinized starch and their mutual proportion, the type of starch and the content of salt [4,11,15]. As it has been reported in literature, the final moisture content in pellets has to be close to 10-12%. Less water than 12% causes that pellets will not puff when immersed in hot oil. More than 12% of water can be the reason of pellets bursting. The important role in the degree of puffing, structure and texture creation plays the quantity and arrangement of tiny droplets of water and little air gaps in the pellet [2,6].

The mixtures for extrusion include usually potato, maize starch and flour as well as another starchy products, mainly cereal origin and different additives [7,13,15]. Some ingredients, like for example fat or dietary fibre can play an important role in the snack quality formation, i.e. changes in colour, the degree of expansion, availability of the nutritive components in food as well as consistency and structure, which, as the structural characteristics of a product, are responsible for mechanical properties, and sensory acceptance [1,3,5,8,14].

The purpose of the experiment was to determine the influence of moisture content in pellets and a dietary fibre addition on the consistency, surface structure and sensory properties of obtained snacks.

MATERIAL AND METHODS

Raw material

There were used for the experiment: potato starch and flour obtained from Potato Factory in Kąty Wrocławskie, modified wheat starch obtained from Potato Factory in Niechlów and maize flour bought in the market. As an additive were used a dietary fibre preparation Vitacel WF 600 – containing 98% of pure [5] fiber, salt and oil. All ingredients were mixed in the proportion which let to obtain 90% of potato products in the mixture.

Pellets processing

There were prepared three variants of mixture: I - without additive of dietary fibre, II- with 5% additive and III-with 10% additive of dietary fibre. Obtained mixtures were brought to the 40% of moisture content. All doughs were packed into polyethylene foil and kept in an ambient temperature. After 24 hours they

were seved to obtain uniform granulation for extrusion process. The extrusion process was done in a laboratory Brabender extruder of 20 DN type. The conditions of the process are presented in Table 1.

Table 1. Parameters of the extrusion process

Parameter	Value
Temperature [^{0}C]	60-65-80
Kind of screw	1:1
Screw speed [rpm]	120
Nozzle dimensions [mm]	30 x 0.5

Obtained extruded products in a shape of ribbon of 30 mm width and 0.5 mm thick were cut on 30 mm pieces and dried in an ambient temperature until they achieved about 10% of moisture content, i.e. about 10 hours. Next, the moisture of pellets was adjusted to the following levels: 8, 10, 12, 14, 16 and 18% with the use of environmental chamber. Ready pellets were kept in polyethylene foil until the next step of the experiment started.

Preparation of snacks

Obtained extruded pellets were fried for 6 to 10 seconds in hot oil, heated up to 180^{0}C [10].

Analysis of semi product and product properties

The sensory properties of snacks, like their appearance, colour, flavour, taste and the consistency were estimated [9,10,16]. An Instron Model 5544 Universal Texture Analyzer was used to determine the textural properties by measuring the resistance to mechanical force (N) expressed as the breaking force i.e., force required to break the snack into pieces. Measuring conditions included: compression load cell capacity – 200 N, cross head speed – 250 mm/min. A movable blade probe (3 mm thick) was used. The measurement of the breaking force was performed twenty times for each sample. The surface structure of snacks was determined by the electron microscopy analysis.

Statistical analysis

The results obtained in the experiment were subjected to statistical calculation according to the Table-curve programme. In order to compare the consistency of snacks obtained from pellets with different contents of moisture and dietary fibre as well as to determine the significance and the character of the dependencies between these features, the analysis of simple regression was performed. The coefficient of determination (r^2) was calculated and the lines of regression described by equation $y = a + bx + cx^2$ were drawn. The chosen model was characterized by the lowest standard error.

RESULTS AND DISCUSSION

Snacks obtained in the experiment differed with regard to crispness, hardness as well as to their appearance and sensory properties according to the quantity of dietary fibre addition and moisture content in pellets. The moisture in obtained snacks was on the suitable level [9,16]. However better expanded snacks, without the addition of dietary fibre, contained less water (Tab. 2).

The moisture content in pellets in the range of 8 – 18% as well as the dietary fibre addition in the quantities of 5 and 10% affected all studied snacks properties. The dietary fibre addition in pellets processing affected slightly the snacks colour (Tab. 2). Light-cream colour of sufficiently expanded snacks without addition of dietary fibre became more cream, orange or brown, in particular in the case when the additive reached 10%. Some authors [3,5,8] using in their experiments dietary fibre preparations stated, that the fiber addition affected snacks colour as well as the taste. It was also noted that the level of pellets moisture related to dietary fibre can have an influence on colour snacks. From pellets with the moisture content: 8% - when no fibre was added, 8 and 10% - when 5% of fibre was added and 8, 10 and 12% - when 10% of fibre additive was used, darker snacks were obtained. The colour of these snacks was cream-brown and light brown. The reason for this was probably non enzymatic browning and carmelization on the surface of unexpanded or not enough expanded snacks, fried several seconds longer than another samples. Suitably expanded potato snacks were characterized by uniform surface with plenty of small blisters of the same size and uniform porosity on cross-section. They were light and crispy [2,4,6,7].

Table 2. Properties of snacks obtained from pellets of different moisture content and quantity of added dietary fibre

Property	Dietary fibre addition [%]	Pellets moisture [%]					
		8	10	12	14	16	18
Colour	0	Light orange	Light cream	Light cream	Light cream	Light cream	Light cream
Consistency		Hard	Crispy	Very crispy	Very crispy	Very crispy	Very crispy
Appearance		Not uniform surface, single large blisters,poor porosity	Lots of small blisters, not uniform surface Sufficient porosity	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section
Moisture [%]		4.59	2.84	2.87	2.31	2.78	3.36
Colour	5	Brown	Cream	Light cream	Light cream	Light cream	Light cream
Consistency		Very hard, "dry"	Hard, "dry"	Crispy	Crispy	Crispy, little hard	Crispy, little hard
Appearance		Almost flat, not expanded, with single blisters	Flat, not expanded, blisters	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section
Moisture [%]		4.72	3.59	3.32	3.01	3.47	4.00
Colour	10	Brown	Light brown	Cream-brown	Cream-brown	Cream	Light cream
Consistency		Very hard, „dry"	Hard, "dry"	Hard, slight crispy	Little hard, not uniform	Little hard, crispy	Crispy, rubbery
Appearance		Flat, not expanded, with single blisters	Flat, distinct blisters, not uniform surface	Not uniform surface and poor porosity	Lot of not regular blisters, poor porosity	Uniform surface, proper porosity of cross-section	Uniform surface, proper porosity of cross-section
Moisture [%]		3.08	3.36	3.23	3.48	3.29	2.87

Snacks obtained from pellets of different moisture contents varied in their expansion and appearance (Tab. 2). The moisture content of 8%, appeared not sufficient for suitable expansion, which should be higher than 3 [2,7,15], with no relation to the dietary fibre content. Obtained snacks were flat, unexpanded, with single blisters. Snacks obtained from pellets of 10% moisture content without dietary fibre additive expanded, but their quality was not suitable, because of not uniform surface structure and porosity of cross-section (Photo. 1A). Blisters were too big and not the same size. Pellets of 10% moisture with 5 and 10% addition of dietary fibre didn't expand when immersed in hot oil (Tab. 2). Single blisters of big sizes appeared on their light-brown surface (Photo. 1B, C). The pellets expansion phenomenon is a result of the properties of raw material, extrusion and drying process parameters [2,6,4,11]. One of the factors is the viscosity of dough during extrusion. It can be influenced by the content of gelatinized starch as well as by the extrusion temperature and the presence of some ingredients, like dietary fibre. The fibre content can reduce the elasticity and plasticity of the dough. The pellets expansion decreases as the per cent of dietary fibre increases [1,3,5,15]. Dietary fibre addition in the quantity of 10% can cause a slight increase in product temperature in the region of the die during extrusion process. Thus, it can affect viscosity of the dough [8,15]. Also relatively high hydrophilic properties of dietary fibre Vitacel WF 600 could decrease the access of starch present in the raw material to water and thus, decrease starch gelatinization [3,5]. Suitable for most pellets moisture content of 12% was not sufficient for pellets with 10% fibre addition (Photo. 1 F). There are noticeable big size blisters. Another samples: without and with the addition of 5% of fibre were characterized by more uniform structure of surface and were more swelled (Photo. 1D, E).

Uniform, regular expansion characterized snacks obtained from pellets: without and with 5% of fibre addition, in the range of moisture content 12-18% and with 10% of fibre addition, in the range 16-18% of moisture. Usually the best level of moisture close to around 10-12%. Water entrapped in pellets, when heated, evaporate and under controlled operation it literally blows the product apart. Besides that, the regular distribution of water in pieces of pellets and little air gaps as well as the thickness of pellets and their outer glass-like layer play an important role. Pellets expand better when their thickness is smaller. Also the outer layer must not be too thick and should contain not less water than 7% because of too large resistance to evaporated water [2,4,6,11].

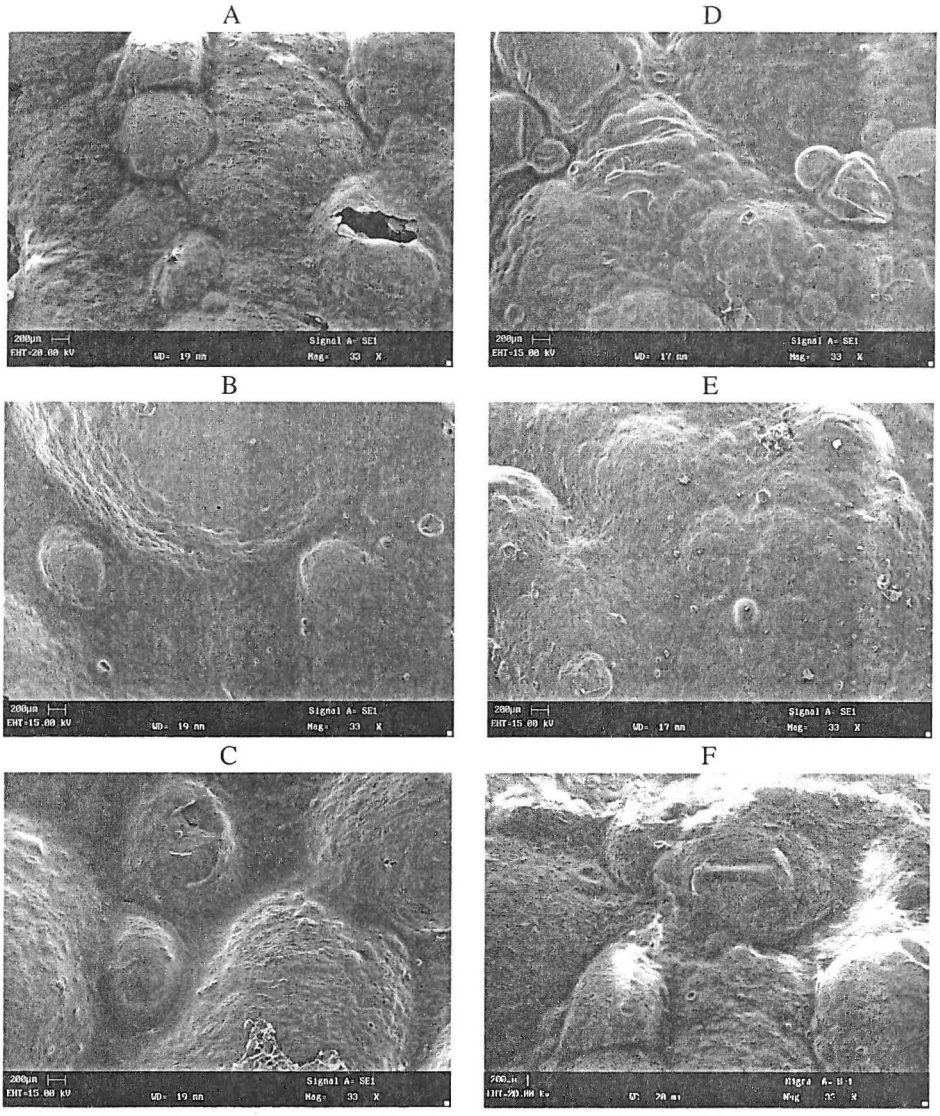

Photo. 1. Microstructure of snacks as a function of pellet moisture content and dietary fiber addition (A - 10% H2O, 0% dietary fiber; B - 10% H2O, 5% dietary fiber; C - 10% H2O, 10% dietary fiber; D - 12% H2O, 0% dietary fiber; E - 12% H2O, 5% dietary fiber; F - 12% H2O, 10% dietary fiber)

Snacks obtained from pellets with 8% of moisture content were of hard or very hard consistency (Tab. 2) with no relation to raw material composition. The breaking force (N) needed to disintegrate product was higher than 19N for snacks without the addition of dietary fibre, about 22N for snacks with the addition of 5% dietary fibre and about 24N for snacks with 10% of fibre addition. Also snacks obtained from pellets with 18% of moisture content and additives of fibre were characterized as more hard than other samples. The sensory as well as an objective tests (Tab. 2, Fig. 1), showed that the suitable crispy consistency of snacks could be achieved when the moisture of pellets was in the range 10-16% for products without dietary fibre addition and with 5% addition (less than 16N needed to break a snack) (Fig. 1). The addition of 10% of fibre caused too hard and too rubbery consistency of snacks (24N or more needed), with no relation to the moisture of pellets. However their appearance suggested suitable expansion and better consistency than it was determined. Probably it was because the chemical composition and structural organization of the material are more important than the appearance as far as textural responses are concerned [2,14].

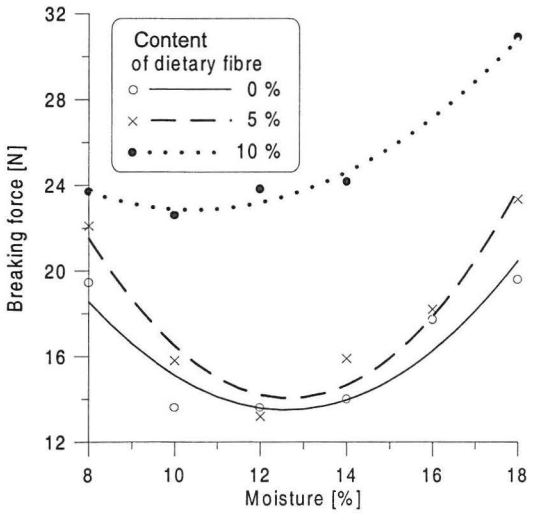

Fig. 1. Effect of moisture content on the consistency of snacks with different addition of dietary fibre

As it was found by the objective texture analysis with the use of Instron texturometer, the consistency of snacks depended on the moisture of pellets and the quantity of added fibre used in the experiment. Correlation between the breaking force (N) needed to break snacks prepared from pellets of different moisture content, both without ($r^2 = 0.86$) (Tab. 3) and with the addition of 5% dietary fibre ($r^2 = 0.95$) and 10% dietary fibre ($r^2 = 0.98$) was described by the equation: $y = a + bx + cx^2$. For the dependence between the consistency and moisture content in pellets, without additive: $y = 51.40 - 6.02x + 0.239x^2$, $y = 69.07 - 8.69x + 0.343x^2$ with 5% of fibre addition and $y = 38.06 - 2.91x + 0.14x^2$ explaining the influence of 10% of fibre addition (Fig. 1).

Table 3. Equations of regression describing the relation between the moisture content of pellets and the consistency of snacks, prepared with the 5 and 10% additive of dietary fibre and without additive

Model	a	b	c	Coeffition of determination r^2	Standard error	Variant
$Y=a+bx+cx^2$	51.40	-6.02	0.239	0.86	1.41	Without additive
	69.07	-8.69	0.343	0.95	1.11	With 5% of fibre addition
	38.06	-2.91	0.140	0.98	0.52	With 10% of fibre addition

CONCLUSIONS

1. Along with the increasing of the amount of moisture content in pellets from 10 to 18%, both without and with 5% of fibre addition, obtained snacks possessed the similar proper quality.
2. Pellets with 10% of fibre addition yielded no snacks of proper consistency and crispness in spite of the uniform expansion and surface structure.
3. The correlation found between the moisture content in pellets with different level of dietary fibre addition and the consistency of obtained snacks is described by the equation $y = a + bx + cx^2$.
4. Results obtained in the performed experiment allows to believe that the proper moisture content in pellets is placed in a proportionally wide range from 12 to 16% and with the fibre contents up to 5%.

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WPŁYW WILGOTNOŚCI SUSZU TYPU „PELLETS" I DODATKU BŁONNIKA NA NIEKTÓRE WŁAŚCIWOŚCI CHRUPEK ZIEMNIACZANYCH

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Streszczenie. Określono właściwości organoleptyczne, konsystencję i strukturę powierzchni chrupek otrzymanych z „pellets" wzbogaconych 5 i 10% dodatkiem błonnika. Badane właściwości chrupek zależały zarówno od wilgotności suszu „pellets" jak również od ilości dodanego błonnika pokarmowego. Wraz ze wzrostem zawartości wilgotności „pellets" z 10 do 18%, zarówno bez dodatku błonnika jak i z 5% jego dodatkiem, otrzymane chrupki odznaczały się podobną, dobra jakością. Stwierdzono istnienie korelacji pomiędzy wilgotnością „pellets" i zawartością w nich błonnika pokarmowego a konsystencją otrzymanych chrupek, wyrażoną przez równanie: $y = a + bx + cx^2$. Otrzymane wyniki badań pozwalają przewidywać, że właściwa wilgotność suszu „pellets" zawiera się w przedziale wilgotności 12-16%, również z dodatkiem błonnika ale nie większym niż 5%.

Słowa kluczowe: "pellets", wilgotność, błonnik, jakość chrupek.