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Deformation characteristic research of albumen belkozin membrane

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1. Introduction

A problem of avoiding food product losses that appear because of the long distance the products travel from the producer to the end user and to maintain good quality is a social concern, not only the economical one. The problem can be solved and food products protected from the environmental factors, including the influence of harmful substances, by a rational use of polymer and protein substances in order that products wouldn't lose their beneficial properties and those product components, which define the nutrition value of a product.

Packaging materials, which directly contact the food products must possess chemical resistivity, have certain physical, chemical, mechanical and technological properties, meet hygiene requirements and assure a high automatization level of the packaging process [1-5].

For packaging of smoked, boiled, liver sausage-meat, also butter, curb, diet curb, curb for children, sour-cream, ice-cream mass and similar consistence products, one of the ways is packaging into various size bar-type film packages closing their ends by metal clips. For this reason there are used film packaging materials made of protein belkozin, polymer povidene and polyethylene, which are suitable for packing the different product brands according to the hygiene, technological and technical requirements [4-6]

The protein belkozin is used for filling of the boiled and smoked sausage meat. The main part of protein film is a protein collagen, which has fibred structure with hard enough separate fibres. These fibres when twisted make up the sieve of quite high mechanical strength. When production the sausages protein casing is under the action, higher temperature, pressure and similar factors which obviously affect its features. These factors must be taken into account when choosing the optimal operation parameters. Especially important is the choise of appropriate soaking medium and duration of keeping a sample in it in order to produce an elastic and nonbreakable casing.

2. Plastification technology of the protein sausage-meat casing

It was determined that soaking of the film in water reduces its strength, which in turn depends upon the duration of the film presence in water. This fact initiated the experiments where the film was soaked not only in water, but other media too. The soaking time t ranged from 60 s up to 48 h. Soaking medium was chosen according to its unharmfullness to humans and the product. Various nutritious fat and their solutions, some salt and alkaline solutions of various concentrations, which acqueate the colagen can be used as such medium. We have chosen the following soaking media: nutritious fat – vegetable oil, fat; acqueous glycerol solution, solution of nutritious soda and acqueous solutions of nutritious salts $NaCl$ and KCl. The influence of the solution concentration on the film strength for various solution concentrations or saturation degree was experimentally determined.

The experiments of film soaking in fat medium indicated that the samples do not become saturated and elastic, no matter the time of their presence in the medium. An attempt to corrugate the film, which was placed in the fat medium showed that it breaks and is not suitable for corrugation. The samples kept in an acqueous glycerol solution, when the saturation degree of the solution is 80-100% do not become elastic too.

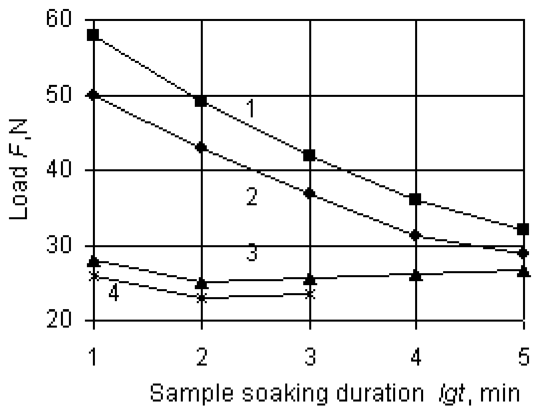

Fig. 1 Dependency of protein belkozin film casing sample rupture load on the soaking duration in the following media: *1* - saturated *NaCl* solution; *2* - saturated KCl_3 solution; *3* - water; *4* - saturated nutritious soda solution. The samples were cut in the transverse direction

In Fig. 1 the dependency of the changes in sample rupture load on the duration of soaking in the various media is shown.

The best strength characteristics were achieved soaking the samples in the salt solutions. The samples proved to be suitable for elastic corrugation. It was experimentally determined that the sample rupture load increases with the increase of the solution saturation degree.

The investigations aimed at determining the dependency of sample strength characteristics on the duration of soaking in the soaking medium indicated that the strength of samples kept in $NaCl$ and KCl solutions decreased with the duration of soaking in the soaking medium. The best experimental results were achieved for the samples soaked in the saturated $NaCl$ solution (Fig. 2). If compared to the samples kept the same period in water it was noticed that the sample rupture load increases by 24%

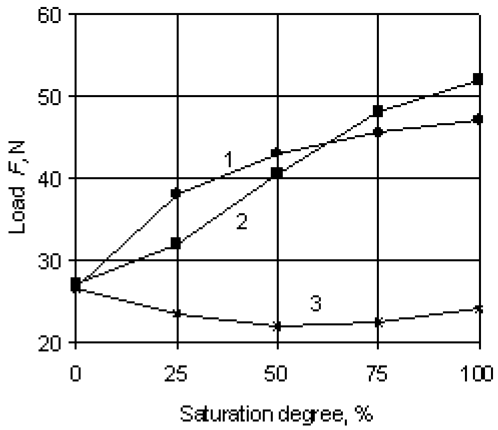

Fig. 2 Dependency of rupture load of protein belkozin film casing on saturation degree of a solution. The samples were cut in transverse direction. The soaking duration in a medium is 60 s. Media: *1* - *KCl*; *2* - *NaCl*; *3* - nutritious soda

to 100 % depending on the soaking duration.

The increase in strength can be explained by the fact that *NaCl* solution is less penetrating than water, molecules of which penetrate into the belkozin structure and weaken the relations between structural elements and thus reduce the strength too. On the basis of the experimental results of soaking belkozin film in various plastification media new soaking and plastification technology for the film casing in hand before forming the sausage products was developed. According to it, in order to strengthen the casing, make it elastic and avoid the so-called pressing through, especially when closing the ends of manufactured sausage bars with metal clips, it is recommended to soak it for 60-120 s in the *NaCl* solution of 20-23% concentration and 291-295 K temperature.

Preparing the belkozin film casing in the operation environment only one side of it is soaked. We have prepared samples under the conditions, which are close to the operation conditions.

It was determined that cleaning of both sides of a sample with water, for 120 s, decreased its strength by even 59.8% in the transverse and 61.7% in the longitudinal direction when compared with the dry film sample. Relative elongation in the rupture moment was 11% in the transverse direction and 44% in the longitudinal one.

If compared to soaking in water, soaking of the samples in saturated *NaCl* solution increases the rupture load up to 79% in the transverse direction and even up to 88% in the longitudinal direction.

3. Investigation of strain properties of protein belkozin film casing, which is filled with the ground meat

When loads were less than rupture loads, the strain characteristics of polymer film materials were determined by relaxation experiments according the method of constant load, performing several loading and unloading cycles and obtaining multicyclic characteristics as a result. The aim of our research was to obtain not the whole range of belkozin film mechanical characteristics, but only these characteristics, which appear under loads in operation conditions.

The creep curve of belkozin film where one can see the increase of the strain under constant load is shown in Fig. 3.

The belkozin sample creep curves in the transverse direction for different loads are presented in Fig. 4.

More comprehensively change of the strain components is presented in Fig. 5. It must be stressed that the change mode of the same components of the strain almost does not depend on the sample cutting direction, and only the absolute strain values differ.

A typical creep curve for seven cyclic loads of a film is shown in Fig. 6. It must be noted that after seven loading and unloading cycles the sample strain changes get stabilized. All the types of strain have a tendency to decrease except for the residual strain component ε_0, which

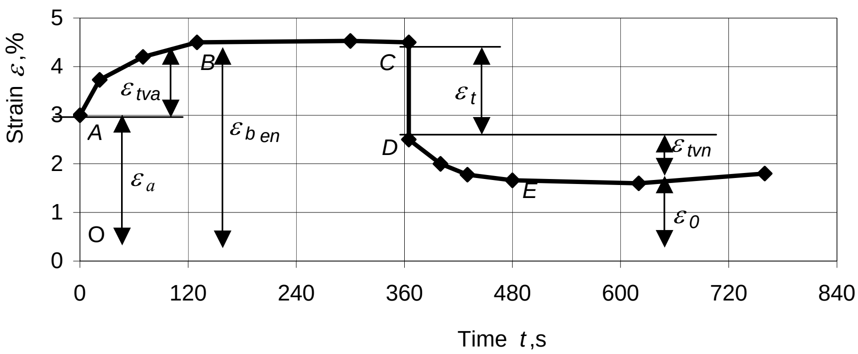

Fig. 3 Creep curve of a protein belkozin film. The samples were cut in the transverse direction. Load – 15 N

increases with an increase in the number of cycles. Every new loading cycle causes smaller and smaller sample deformations and the deformation amplitude constantly decreases. This happens because of the decrease of total ε_{ben} and the increase of residual ε_0 strain component in each cycle.

In the investigated case soaked film samples were examined. The total strain could have decreased because of their shrinkage. Shrinkage of the samples is influenced by ununiform state of its structural elements. When the interconnections in these elements get weaker, the elements get into a more stable condition and shorten as a result.

Experiments indicated that during this time period a sample shrinks by 10-11%. Meanwhile, in the case of a cyclic load it shortens by 17-24%. Thus it can be stated that together with sample shrinkage its shortening occurs, as because of cyclic loads the configuration of structural joints changes.

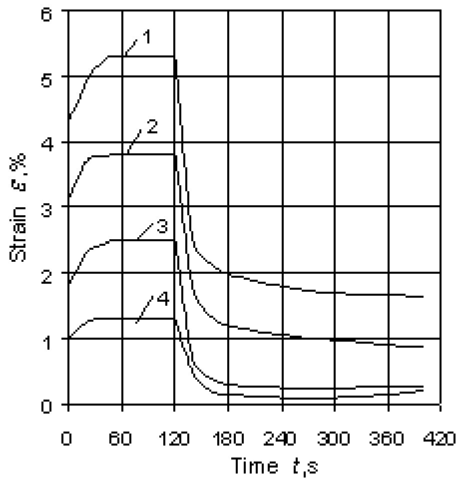

Fig. 4 Dependency curve of the protein belkozin film creep depending on load. The samples were cut in the transverse direction. Load: *1* - 20 N, *2* - 15 N, *3* – 10 N, *4* - 5 N

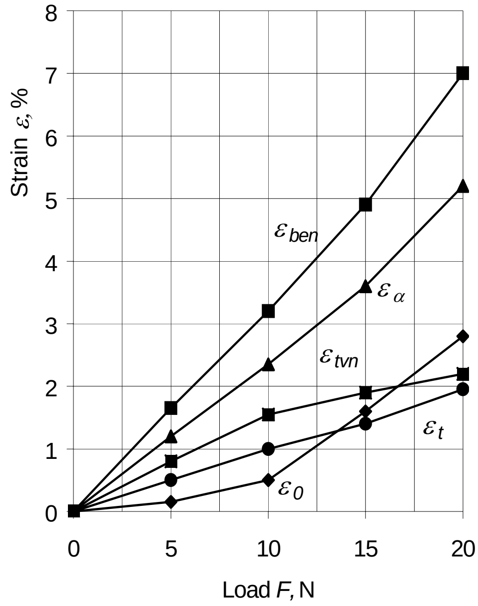

Fig. 5 Dependency curves of the change in strain components depending on the applied load. The samples were cut in the transverse direction

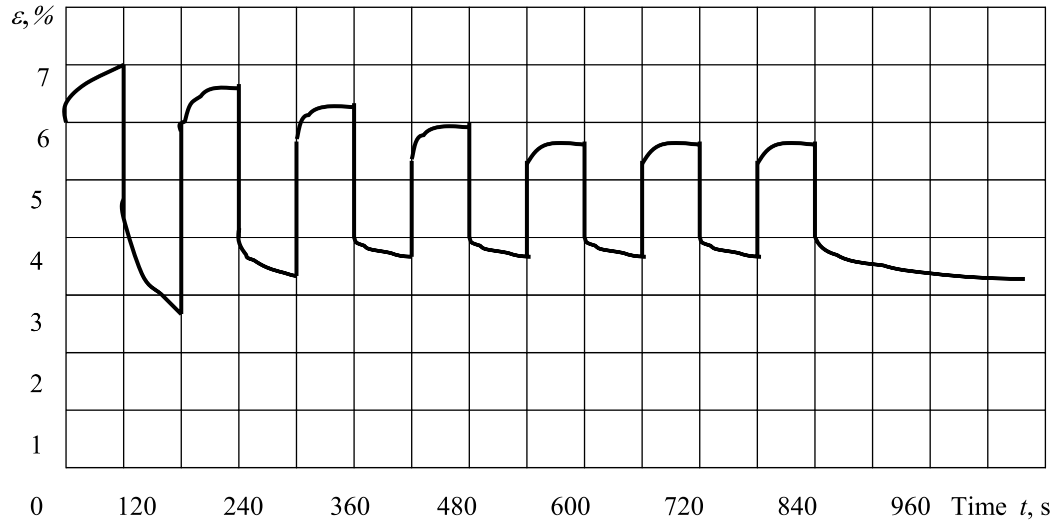

Fig. 6 Creep curve of protein belkozin film in the case of seven cycle loads. The samples were cut in the transverse direction. Load - 20 N

The experimental results have pointed out the following important properties of belkozin films:

- in the case of cyclic loads, the rigidity of a film increases, and the total strain decreases together with the sample shrinkage;
- an instantaneous moment residual strain occurs and increases with every load cycle;
- the changing mode of the belkozin film strain components in the longitudinal and transverse direction is the same, only absolute values of the strain differ, and they are higher in the transverse direction.

4. Conclusions

1. Plastification technology of protein belkozin film casing, before filling it with the sausage-meat, was developed. It was determined that after keeping a protein casing sample in the saturated NaCl solution of 291-295 K temperature for 60-120 s, the sample rupture load increased up to 2 times if compared to the samples kept for the same period in water.

2. The dependency of the laws of change of the load components on load and the number of loading cycles was determined. It was found out that under multiple loads the rigidity of belkozin increases, which in turn decreases the total strain during every new loading cycle, and the deformations of samples cut both in the latteral and transverse directions change in the same manner. It was determined that an instantaneous residual strain is characteristic to belkozin film and under cyclic loading it decreases considerably after the first cycle and later decreases further as the number of cycles increases.

3. The changes in belkozin rupture load and residual strain in the rupture moment with respect to the number of loading cycles and the load magnitude were investigated. It was determined that in the case of optimal

58-62% rupture load and 4 loading cycles respectively, the rupture load increases by 10-11% and residual strain in the rupture moment increases by 15-20%.

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BALTYMINĖS BELKOZINO PLĖVELĖS APVALKALO DEFORMACINIŲ SAVYBIŲ TYRIMAS

R e z i u m ė

Pateikta baltyminės belkozino plėvelės apvalkalo plastifikavimo, prieš kemšant į jį dešrų faršą, technologija. Nustatyta, kad baltyminio apvalkalo bandinio, 60-120 s išlaikyto sočiajame NaCl tirpale 291-295 K temperatūroje, trūkio apkrova padidėja iki dviejų kartų, palyginti su bandiniais, tiek pat laiko išlaikytais vandenyje.

Tirtos baltyminės belkozino plėvelės deformacinės savybės. Nustatyta belkozino plėvelės tampra išilgine ir skersine kryptimis esant ciklinėms apkrovoms. Išsiaiškinti deformacijos sudedamųjų dalių kitimo dėsningumai ir jų priklausomybė nuo apkrovos dydžio ir apkrovimo ciklų skaičiaus, taip pat kitos charakteristikos, kurias būtina žinoti tobulinant dešrų faršo kimšimo į baltyminės belkozino plėvelės apvalkalą technologijas, automatizuojant gamybą ir parenkant optimalius įrenginių darbo parametrus.

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DEFORMATION CHARACTERISTIC RESEARCH OF ALBUMEN BELKOZIN MEMBRANE

S u m m a r y

Plastification technology of protein belkozin film casing, before filling it with the sausage-meat, is presented. It was determined that after keeping a protein casing sample in the saturated NaCl solution of 291-295 K temperature for 60-120 s, the sample rupture load increased up to 2 times if compared to the samples kept for the same period in water.

Samples resiliency in longitudinal and transversal membrane directions in the presence of cyclic loading have been established. Regularities of component deformation change the amount and the number of loading cycles as well as other characteristics necessary to develop technologies, to automate the manufacturing and to choose the equipment optimum work parameters before filling the covering with sausage-meat are investigated.

Л. Паулаускас, Р. Каирайтис

ИССЛЕДОВАНИЕ ДЕФОРМАЦИОННЫХ СВОЙСТВ БЕЛКОВОЙ ОБОЛОЧКИ БЕЛКОЗИНА

Р е з ю м е

Представлена технология пластификации белковой колбасной оболочки белкозина при набивке фаршем. Установлено, что сила разрыва образца белковой оболочки, выдержанного 60-120 с в насыщенном NaCl растворе при температуре 291-295 K, увеличивается в два раза по сравнению с образцами, столько же выдержанными в воде.

Представлены исследования деформационных свойств белковой колбасной оболочки белкозина. Установлены прочностные свойства и ползучесть рукава оболочки белкозина при цикловом нагружении в продольном и поперечном направлениях. Определены основные деформационные свойства белкозина, проведен анализ составных частей деформации в зависимости от числа циклов и величины нагрузки, а также другие характеристики, необходимые для усовершенствования технологий, автоматизации производства и выбора оптимальных параметров при набивке оболочек фаршем.

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