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THE STRUCTURAL MODIFICATION OF VEGETABLE PROTEIN PREPARATIONS BY HIGH AND LOW PRESSURE EXTRUSION-COOKING PROCESSES

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Key words: soybean flours and concentrates, rapeseed flours and concentrates, structure of protein preparations.

Flours and concentrates obtained from the soybean and rapeseed, and soybean-rapeseed blends (1:1), were textured by high and low pressure. The structures of protein preparations by extrusion-cooking processes were investigated using scanning electron microscopy.

INTRODUCTION

In recent years, many interesing advances have been made in the preparation of textured plant proteins from powdery and globular protein material [3, 4, 5]. These processes transform a powdery (amorphous) protein material into linear structures which have texture, described as chewiness, and a fibrous character that adds functionality to processed foods. These textured protein products have aplications primarily in food systems based upon ground and imitation meat products [6].

In our investigation, the structures of textured plant protein preparations such as flour and concentrates obtained from soybean and rapeseed, and blends prepared by mixing the rapeseed concentrate and soybean flour in the ratio of 1:1, were studied for their structural characteristics after extrusion-cooking by high and low pressure processes. The high pressure process, produces a product with particular application as a meat extender while the low pressure product is suitable for the manufacture of meat analoques.

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EXPERIMENTAL

The plant protein preparates were textured by extrusion-cooking processes using the X-20 model (high pressure) and by the UNI-TEX model X-25 CF-CB and X-25 (low pressure) manufactured by Wenger CO. USA.

During the high pressure extrusion-cooking process the protein products were moistened to 20-25% while the flour material was being converted into a dough. Conversion of the moistened material into a dough occurs inside the extruder assembly under partial vacuum as the moistened materials are being mixed at a temperature of 80-90°C. After mixing, the temperature was elevating during the last 10 to 30 seconds in the extruder to the desire extrusion temperature (120-200°C) to cook and expand the products. Desired size and shape of the final product was formed in a die. The final product was dried and cooled.

The meat analoques were produced using two specialized extrusion-cookers (UNI-TEX process). In the double extrusion process, one cooking extruder discharges a moistened, heated and denaturated protein into a second similar but elangated extrusion cooker. The final product was cut into desired bite-sized chunks and then was dried and cooled.

The investigation of structure of textured plant protein preparations were conducted using scanning electron microscopy (SEM JOEL CO.) under accelerating voltage of 10 KV. The samples for electron microscopy was made using 3% aldehyde gluterate followed by dehydration with nitrogen. Finally the samples were coated with carbon and gold [2].

RESULTS AND DISCUSSION

The histological studies (Fig. 1, 2) ilustrate the structure of soy flour and rapeseed concentrate after the high pressure extrusion-cooking process. The structure of soybean flours after extrusion-cooking shows no parallel fibres, while rapeseed concentrate has fibres which are more parallel to each other and also show some interconnecting branches. This can be explained on the basis of the cell-wall structures which have been fragmented in rapeseed concentrate, freeing the globules of protein to run together.

The structure of rapeseed concentrate and soybean flour, after the low pressure process, is shown in Figures 3 and 4. The picture shows that material made by the UNI-TEX process resembles meat in appearance and structure. The protein strands are stretched into ribbons and are overlaid tangentially, creating the laminar and musclelike structure. The linear strands give these textured proteins their chewiness after rehydratation.

More interesting results were obtained when the low pressure UNI-TEX process was used for texturisation of the blend of soybean flour

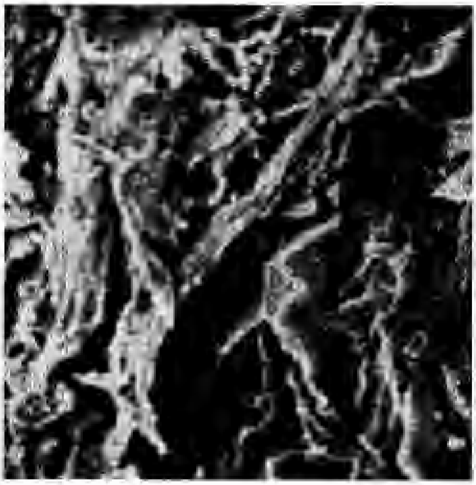

Fig. 1. The structure of soy flour visible in SEM after extrusion-cooking process, mag 2000×

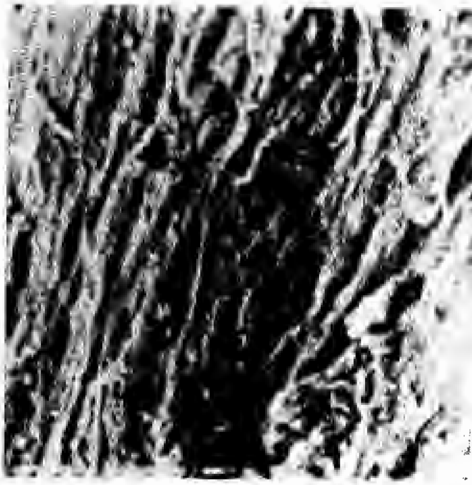

Fig. 2. The structure of rapeseed concentrate visible in SEM after extrusion-cooking process, mag 2000×

Fig. 3. The structure of rapeseed concentrate visible in SEM after UNI-TEX process and hydratation, mag 2000×

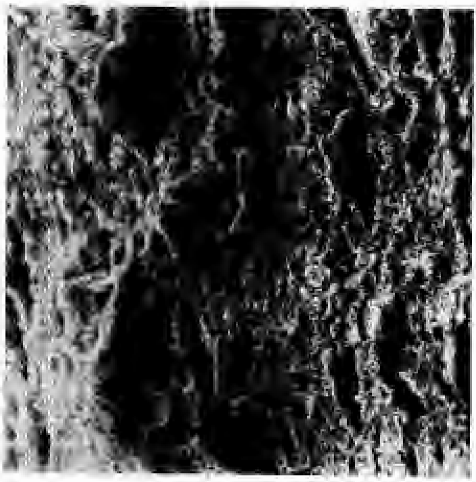

Fig. 4. The structure of soybean flour visible in SEM after UNI-TEX process and hydratation, mag 2000×

and rapeseed concentrate in the ratio 1:1 by weight (Fig. 5). In this case the layers of the obtained analoque are uniform, untwisted and parallel. Cross linkage bridges can be seen between the fibres which make the structures resemble meat tissues even more than for rapeseed or soy alone. The mouthfeel of those products was better than those of the products made from rapeseed concentrate or soybean flour alone.

Using both techniques, extrusion-cooking process and ONI-TEX process, we are able to improve the structure of protein preparates which

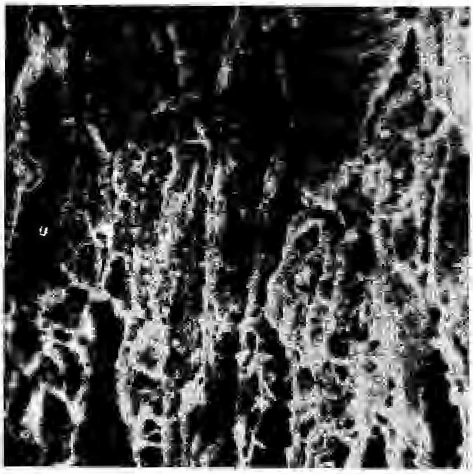

Fig. 5. The structure of rapeseed concentrate and soy flour mixture (1:1) after UNITEX process and hydratation visible in SEM, mag 2000×

can be introduced into the food products as meat extenders or as meat analoques. Texturisation resulted no changes in amino acid composition. High contents of sulfur amino acids in protein preparates obtained from rapeseed suggested that this protein would be a good source for supplementation of other vegetable proteins e.g. soybean [1].

LITERATURE

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MODYFIKACJA STRUKTURY BIAŁKOWYCH PREPARATÓW ROŚLINNYCH W PROCESACH EKSPANDOWANIA (EXTRUSION-COOKING PROCESS) I UNI-TEX

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S t r e s z c z e n i e

Mąkę sojową oraz koncentrat białka rzepakowego poddano procesowi tekstu-racji metodą ekspandowania i UNI-TEX. Teksturację przeprowadzono na ekstruderach X-20 (ekspandowanie) i X-25 CF-CB (UNI-TEX) produkcji Wenger International Co. w Sabatha, Kansas City, USA. Otrzymane teksturaty poddano obserwacji pod skeningowym mikroskopem elektronowym w celu ustalenia zmian struktury preparatów białkowych pod wpływem zastosowanych procesów.

Stwierdzono istotne różnice w strukturze produktów otrzymanych z różnych surowców i różnymi technikami. Obserwacja obrazów mikroskopowych wykazała, że proces ekspandowania zapoczątkował formowanie się włókien. Ułożone były one w sposób bardziej uporządkowany w teksturacie otrzymanym z koncentratu białka rzepakowego (rys. 2) niż z mąki sojowej (rys. 1). Struktura teksturatów otrzymanych techniką UNI-TEX, bardziej niż teksturaty otrzymane techniką ekspandowania, przypominała tkankę mięśniową (rys. 3 i 4). Interesującą strukturę posiadały teksturaty otrzymane z mąki sojowej i koncentratu białka rzepakowego. Ilustruje to rys. 5, na którym widoczne są połączenia poprzeczne uformowanych włókien.