INFLUENCE OF UNCONVENTIONAL PROTEINS ON THE TEXTURE/CONSISTENCY PROPERTIES OF MEAT PATTIES

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Unconventional proteins are incorporated into food products mainly to improve the functional properties. However, changes in such properties as emulsion capacity and water and fat holding capacity also affect texture/consistency of the food.

Determination of texture/consistency in patties containing different types and amounts of unconventional proteins was performed by instrumental and sensory analyses.

In the instrumental analyses an Instron Universal Material Testing Machine equipped with a meat shear cell was used.

Hardness, elasticity, chewiness, and juiciness of the patties were ratio estimated by a laboratory panel and hardness, chewiness, juiciness, and overall consistency were scored by a "consumer" panel of 15 persons.

The instrumental analyses showed that addition of Texgran 10.000 (an extruded soy flour), Promine-D (soy isolate), rapeseed protein concentrate, and sodium caseinate resulted in decreases in force and work values registered. At an increasing addition of Dipro F 70 (an extruded mixture of soy flour and soy isolate) the corresponding values first increased and then decreased. Results from sensory properties showed mainly the same trends.

When instrumental and sensory variables were related to each other with multiple linear regression analysis, it was shown that the concept of overall consistency could be split up into three levels of measurements. At the bottom laid physical properties of the patties which reflected certain sensory texture/consistency properties. These properties in their turn built up the concept of overall consistency.

INFLUENCE DE PROTÉINES NON-CONVENTIONELLES SUR LES PROPRIÉTÉS DE TEXTURE/CONSISTANCE DES STEAKS HACHÉS

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Des protéines non-conventionelles sont mélangées aux protéines alimentaires, principalement afin d'améliorer les qualités fonctionelles. Cependant, des modifications des propriétés, telle la capacité d'emulsion ainsi que la capacité de rétention d'eau et de graisse, agissent également sur la texture/consistance de l'aliment.

La détermination de la texture/consistance dans les steaks hachés, contenant différents types et différentes quantités de protéines non-conventionelles a été réalisée à l'aide d'analyses instrumentales et organoleptiques.

Dans les analyses instrumentales l'Instron Universal Material Testing Machine, munie d'une case de cisaillement, a été utilisée.

Dureté, elasticité, "chewiness" et succulence des steaks hachés ont été estimés par la biais d'un jury de laboratoire et dureté, "chewiness", saveur et consistance générale ont été évalués à l'aide d'un jury de "consommateurs" comprenant 15 personnes.

Les analyses instrumentales ont mis en évidence que l'addition de Texgran 10.000 (farine de soja extrudée) de Promine-D (isolat de soja), concentrat de la protéine de colza et sodium caséinate avaient pour résultat des valeurs diminuées de force et de travail qui ont été enregistrées. Avec l'addition augmentée de Dipro F 70 (une mélange extrudée de la farine et de l'isolat de soja), les valeurs correspondantes ont d'abord subi un accroissement et puis un abaissement. Des résultats obtenus des propriétés organoleptiques ont indiqué, en principe, les mêmes tendances.

Quand les variables instrumentales et sensorielles ont été combinées par l'analyse de "multiple linear regression", l'on a remarqué que la conception de consistance générale pouvait être divisée en trois niveaux de mésures. Tout au fond étaient les propriétés physiques des steaks, reflétant certains caractères de texture/consistance sensoriels. Ces qualités ont, à leur tour, formé la notion de consistance générale.

H1:2

EINFLUSS UNKONVENTIONELLEN PROTEINEN AUF TEXTUR/KONSISTENZ VON HAMBURGERN

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Unkonventionelle Proteine werden Lebensmitteln hauptsächlich zur Verbesserung der funktionellen Eigenschaften zugesetzt. Veränderungen z.B. der Emulsionsfähigkeit und der Wasser- und Fettbindung wirken auch auf die Textur und Konsistenz der Lebensmittel ein.

Textur und Konsistenz von Hamburgern mit verschiedenen Quantitäten von verschiedenen Typen von unkonventionellen Proteinen wurden instrumentell und sensorisch bestimmt.

Zu den instrumentellen Analysen wurde eine Instron Universal Materialprüfungsmaschine, mit einer "meat shear" Zelle ausgerüstet, verwendet.

Hartheit, Elastizität, "Chewiness" und Saftigkeit wurden in Paarvergleichen von einem Laboratorienpanel beurteilt. Ausserdem wurden Hartheit, "Chewiness", Saftigkeit und totale Konsistenz von einem "Konsumentenpanel", bestehend aus 15 Personen gemäss linearer Skala bewertet.

Die instrumentellen Analysen zeigten bei Zusatz von Texgran 10.000 (ein extrudiertes Soja-Mehl), Promine-D (Sojaisolat), Rapsproteinkoncentrat und Natriumkaseinat eine Abnahme der registrierten Kraft- und Arbeitswerte. Bei steigendem Zusatz von Dipro F 70 (eine extrudierte Mischung von Sojamehl und Sojaisolat) nahmen die Werte zuerst zu und dann ab. Die Resultate der sensorischen Analysen zeigten im grossen und ganzen dieselbe Tendenz.

Bei einem Vergleich der instrumentellen und die sensorischen Variabeln mittels "multipel linear regression" Analyse ergab sich, dass der Eindruck der "totalen Konsistenz" in drei Stufen gespaltet werden kann. Zugrunde lagen die physikalischen Eigenschaften von den Hamburgern, die spezielle sensorische Textur- und Konsistenzeigenschaften wiedergaben. Diese Eigenschaften bauen ihrerseits den Eindruck "totale Konsistenz" auf.

ВЛИЯНИЕ ОСОБЫХ БЕЛКОВ НА ТЕКСТУРУ/КОНСИСТЕНЦИЮ "ПАТТИ"

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Особые белки вводятся в пищевые продукты в основном для улучшения функциональных свойств. Однако, изменения в таких свойствах, как эмульгируемость, способность к удержанию воды и жира также влияют на текстуру/консистенцию пищевых продуктов.

Изучение текстуры/консистенции в "патти", содержащих различные типы и количества особых белков, выяснилось проведением анализов с помощью приборов и дегустацией.

Анализы выполнялись с помощью универсальной машины Инстрон для испытания материалов, оборудованной устройством для нарезания мяса.

Твердость, упругость, поддаваемость жеванию и сочность "патти" определялись лабораторным методом и те же качества, за исключением упругости, а также общая консистенция, определялись группой дегустаторов из 15-ти человек.

Анализ, выполненный с помощью приборов, показал, что результатом добавления Texgran 10.000 /формованная способом экструзии соевой муки/, Promine-D /соевые изоляты/, концентрата белка репсового семени и натриевого казеина является понижение величин показателей силы и работы. С увеличением добавления Dipro F 70 /формованные способом экструзии соевая мука и соевые изоляты/ соответствующие показатели сначала увеличиваются, а затем уменьшаются. Результаты дегустации показали в основном те же тенденции.

При сопоставлении показателей, полученных обоими способами, с использованием комплексного анализа линейной регрессии, было показано, что понятие общей консистенции может быть разбито по трем уровням измерений. Положенные в основу физические свойства "патти" отображают определенные свойства текстуры/консистенции, действующие на органы чувств. Данные свойства, в свою очередь, создают понятие общей консистенции.

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INTRODUCTION

The use of unconventional protein products, mainly different types of soy proteins, has during the last decade become more and more common. This is partly due to the fact that addition of such proteins to food products will posetively influence the nutritional and economical factors (Ohlson, 1970). Furthermore, functional properties of the products will be affected (Wolf and Cowan, 1971). It can, however, be assumed that if such functional properties as, e.g., water absorption capacity, fat absorption capacity, and emulsifying properties are changed, also texture/consistency in the food will be influenced.

Most articles in the food literature regarding unconventional proteins in minced meat products deal with nutritional properties and determinations of such parameters as colour changes and fat and water losses during frying. Only a little number of articles take specific texture/consistency properties into account.

1) Huffman and Powell (1970) concluded that patties containing 2% soy bits were significantly more tender than patties without soy bits.
2) Mize (1972) investigated the preference of patties by using a consumer panel. She found that the "general liking" and the "acceptance of tenderness" increased, when 2% soy bits were added to the formulation.
3) Hermansson (1975) showed that texture changes occured, when 4% soy protein isolate, caseinate, and whey protein isolate, respectively, were incorporated into a meatball formulation.
4) When Bowers and Engler (1975) added textured soy protein to patties, the firmness increased and the "overall acceptability" decreased.

The purpose of the present investigations was to study the influence of different amounts of unconventional proteins on the texture/consistency properties of patties.

EXPERIMENTAL

General experimental design

Table I shows the general design of the experiments. The analyses were divided into five sets, each set containing one type of protein preparation in different amounts. The five sets were analyzed within a time span of totally 21 months.

Instrumental determinations of texture/consistency properties were performed with the aid of an Instron Universal Testing Machine and a SuR-penetrometer. Parallelly with these analyses sensory evaluations of the patties were run by using a laboratory panel of six persons.

As a supplement to the above-mentioned experiments, an investigation especially directed towards analysis of the overall consistency of the patties was accomplished by means of a 15-member panel in a sixth set.

Material

The protein products investigated are tabelled in Table I for set 1-5 and in Table II for set 6.

As can be seen different amounts of rehydrated protein were added in different sets. This was due to the fact that different protein preparations had different water absorption characteristics. The ratio between added protein and water, therefore, had to be varied. It should otherwise have been impossible to shape the patties in the food portioning machine.

The patties without addition of unconventional protein ("the 0%-patties") contained just minced meat (beef residues; "Nöt III"). In all other patties part of the meat was substituted by rehydrated protein. In order to maintain a fat content of about 20% in the patties, extra lard was added to the patties containing unconventional proteins.

The patties (64 g weight; 9 cm diameter; 0.8 cm thickness) were frozen raw and stored in polyethylene bags (N_2-athmosphere) until they were analyzed. Before analysis they were thawed and contact fried for 8 minutes in margarine at 175 °C temperature (of margarine).

Methods of analysis

Instrumental analysis (sets 1-6)

The instrumental experiments were mainly performed with an Instron Universal Testing Machine supplemented with some minor tests in a SuR-penetrometer.In Instron as well penetration tests as tests with a meat shear cell were run.

Penetration tests in Instron: A plunger (3 cm diameter) penetrated the patties with a constant speed of deformation (1 cm/min.) until it had reached a distance of 5.5 mm from the surface of the load cell. The patties were thereby deformed to 50-55% of their original heights. Force/deformation curves were registered.

Tests with the meat shear cell in Instron: Strips of the patties (4.5 cm wide) were cut by an up- and downwards moving vertical plate ("guillotine"). The deformation speed was 1 cm/min. Force/deformation curves were registered.

Penetration tests in a SuR-penetrometer: A plunger (3 cm diameter) was allowed to fall into the patties by the action of the force of gravity. The weight of the plunger was 540 g. The penetration as a function of the time was registered.

Sensory evaluations

Ratio-estimations (sets 1-5): A semi-trained panel consisting of six persons from the laboratory personnel was used. The panelists judged six different properties: hardness and elasticity by pressing the patties with the fore-finger ("at handling"); hardness elasticity, chewiness, and juiciness with the molar teeth involved ("at biting"). All properties were defined in advance. For each property all possible combinations of patties within each set were estimated by using a ratio-estimation technique. The panelists were asked to indicate which of the two samples within the pair that had the greatest intensity regarding the actual property. The intensity of this sample (=the "reference sample") was assigned the value 100. Then, the intensity of the other sample within the actual pair was estimated in percent of the intensity of this "reference sample". Thus, if the intensity of a sample was peceived as half of the intensity of the other ("reference") sample, it was assigned the value 50.

Scoring (set 6): Hardness, chewiness, juiciness, and overall consistency were scored by a panel consisting of 15 persons (mainly house-wives). Ten-point rating scales with anchored end-points were used. During the five initial sessions the 0%-patty was judged. The scores then obtained for each property were during the the following sessions marked on the questionnaire and the 0%-patty was used as a comparison sample.

RESULTS AND DISCUSSION

Instrumental analysis

As an example of the results obtained Figure 1a shows the deformation work values obtained with the meat shear cell as a function of the amount of rehydrated protein added. In Figure 1b data from Figure 1a have been normalized by dividing the work values for patties containing unconventional protein with the work values for the patties without protein. (The variation in deformation work between the 0%-patties in different sets, as can be seen in Figure 1a, was due to the fact that different bathes of meat had to be used in the different sets.)

From the figures it can be seen that the deformation work for patties containing Dipro F 70 increased when 16 and 32% rehydrated protein were added. When the protein addition were 48% the deformation work decreased to a level below that of the 0%-patty. The deformation work values for patties containing the other types of protein preparations all decreased monotonously with incresing amount of rehydrated protein.

On the whole the results from the penetration tests in Instron agreed with the above-mentioned results.

Penetration tests in the SuR-penetrometer revealed just a few significant differences between different samples. Presumably, this was due to the fact that loads of only 540 g were used. The penetration of the plunger into the patties was therefore in general not greater than 2-3 mm. The texture of the frying crust could thus have contributed to the penetration values much more than at penetration in Instron, where the loads are at least ten times greater.

Sensory evaluations

Ratio-estimations

Figure 2 shows, as an example of the results of the ratio estimations, hardness at biting plotted against amount of rehydrated protein added. As can be seen the trends are the same as in Figure 1b, i.e., patties containing Dipro F 70 have a maximal hardness after addition of 16-32% rehydrated protein, while hardness for patties containing all other types of protein continously decrease with increasing content of unconventional protein.

Hardness at handling and chewiness was highly correlated ($r > 0.92$) to hardness at biting.

For patties containing Dipro F 70 as well elasticity at handling as elasticity at biting showed no significant change with increasing amount of protein added. When other types of unconventional protein were added the elasticity, however, decreased with increasing amount of rehydrated protein. The absence of significant differences for patties containing Dipro F 70 may be an effect of too little training of the panel before the evaluations of that set.

No significant differences in juiciness between patties containing different amounts of unconventional protein could be noticed in any of the sets.

Scoring

Hardness and chewiness of the patties decreased with increasing amount of rehydrated protein for all protein preparations.

The patties became more juicy when the amounts of Dipro F 50 and Texgran 10.000 were increased. When Promine-D was added juiciness decreased with increasing amount of protein added. On the whole "overall consistency" showed the same trends as juiciness.

It can be observed that the texture/consistency of patties containing Dipro F 70 and Dipro F 50, respectively, differed from each other. This can be explained by the fact that Dipro F 70 is manufactured from a mixture of soy flour and soy isolate, while Dipro F 50 is manufactured from just soy flour. Thus, Dipro F 50 could be expected to have properties similar to other textured preparations made from soy flour, e.g., Texgran 10.000.

It can also be observed that clear trends in juiciness were obtained in the scoring tests but not in the ratio-estimations discussed above. However, one must bear in mind that two different panels were used in these analyses. This can perhaps explain the difference

Relations between instrumental and sensory variables

Variables calculated from instrumental analyses(penetration tests in Instron and the SuR-penetrometer; deformation tests with a meat shear cell in Instron; determinations of fat and water content and of weight losses during frying) were reduced in number from 19 variables to three factors by the aid of factor analysis. The three sensory variables (hardness, chewiness, and juiciness) were redeuced to two simply on basis of the correlation coefficients between them and the regression lines obtained when plotting the three variables in all possible combinations.

The instrumental and sensory factors obtained were then related to each other by the aid of multiple linear regression analysis. The results from the calculations are summarized in Figure 3. The concept of overall consistency is there split up into three levels of measurements. At the bottom (level 3) lie the physical properties of the material, which reflect certain sensory texture/consistency properties on level 2. These properties can, in their turn, build up the concept of overall consistency on level 1. According to the correlation coefficients, overall consistency can be built up directly from the physical properties without too much loss of precision.

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Table I. Amounts of different proteins (%) added to patties used in ratio-estimations.

Set Nr	Type of protein	Level of protein addition 0	1	2	3
1	Dipro F 70 *)	0	16	32	48
2	Texgran 10.000 *)	0	16	32	48
3	Promine-D **)	0	6	12	24
4	Rapeseed Protein Concentrate (RPC)**)	0	10	20	40
5	Sodium Caseinate Spray Blend **)	0	6	12	18

*) Textured by thermoplastic extrusion
**) Untextured preparations

Table II. Amounts of different proteins (%) added to patties used in scoring tests.

Type of protein	Level of protein addition 0	1	2	3
-	0	-	-	-
Dipro F 50 *)	-	16	32	48
Texgran 10.000 *)				
Promine D **)	-	8	12	24

*) Textured by thermoplastic extrusion
**) Untextured preparation

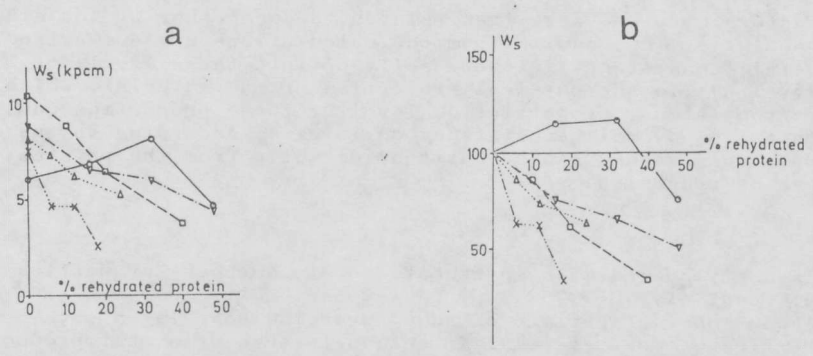

Figure 1. The deformation work obtained from the meat shear cell curves plotted against the amount of rehydrated protein.

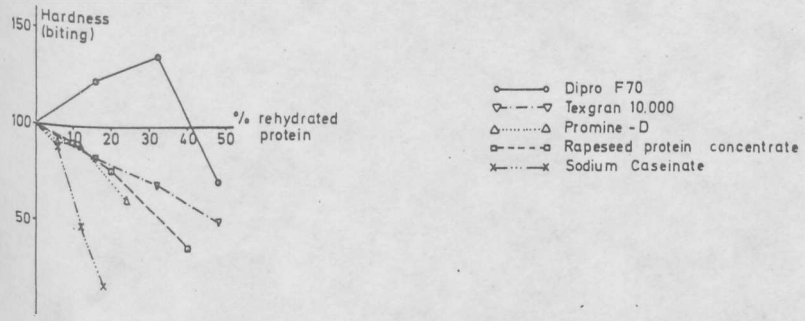

Figure 2. Hardness at biting obtained at ratio-estimations plotted against the amount of rehydrated protein.

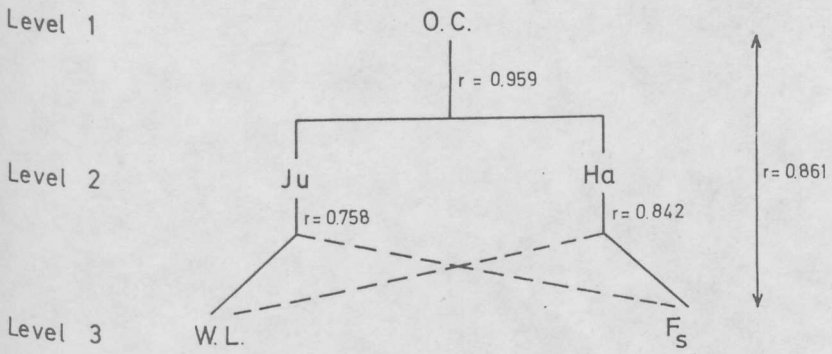

Figure 3. Schematic split up of overall consistency in three levels of measurements.
O.C.=Overall consistency
Ju = Juiciness
W.L.= Weight losses during frying
Ha = Hardness
F_S = Deformation force (meat shear cell)