Simulierte Fleischfasern von Blutplasma Proteinen.

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Blutplasma, durch Gefrieren bis ein Proteininhalt von ca. 120 mg/ml verstärkt, kann in fleischähnlichen Fasern ausgezogen werden, vorausgesetzt dass unveränderliche Viskositätsbedingungen (ca. 250P) festgestellt sind. Eine solche Unveränderlichkeit kann durch hinzufügen von NaOH erreicht werden, bis man ein Verhältnis von NaOH/Protein 1:10 erhält. Dies veranlasst ein deutliches Steigen bis 50P in 15 Minuten; als Folge Essigsäure hizugefügt wird, um das pH von 12 zu 11 zu reduzieren. Der so gebildete Proteinlack wird um 1.4 - 2.1 kg cm^{-2} in ein 20% NaOH in 1M Essigsäure enthaltendes Bad gepumpt, entwickelnd Fasern die als ein "Schleppen" über Godet rolls zurückgezogen werden konnen. Hohe strangpressende Geschwindigkeit von den Spinndüsen verursacht einen höheren willkürlichen Anhäufensgrad von dem Protein in den Fasern; während hohe zurückziehende Geschwindigkeiten die Tendenz haben, die Fasern zu zerbrechen.

Die produzierte Fleischähnliche Fasern haben ungefähr 17% Protein und 73% Feuchtigkeit. Der Aschengehalt ist hoch; der kann aber durch Spülung auf einen Aschengehalt typisch von magerem Fleisch reduziert werden.

Völlig aus Blutplasma Proteinen gesponnene Fasern, obgleich alle die esentiellen Amidosäuren enthaltend, neigen zu einem weniger als optimalen Inhalt von Isoleucin und Methionin. Dies kann vor der Spinnerei rektifizert werden, durch hinzufügen von ca. 20% Protein ausgezogen mit Alkali von anderem Schlachthausabfall solche wie Lugen und Magen. Wenig Lysino Alanin wird produziert, vorausegesetzt dass das Ausziehen der Letzteren unter 40°C auseführt wird.

Wie aus Rattenfütternden Erprobungen geschlossen, vergrössert die Spinnung solcher Fasern die Nettoproteinverwendung in Vergleich mit derjenigen des originalen Proteinextracts, trotz einer geringen Verminderung des Methioninhalts. Die Verbindung manches Hämoglobin von dem korpuskularen Bruch des Bluts beliefert Eisen in einer absorbierbaren Form; (so Vorteile leistend über Pflanzenprotein-hergerichtete Fleischanalogen) und verhilft Fleischfarbe zu simulieren.

Der mikrobiele Zustand der gesponnenen Fasern ist befriedigend. Sie sind um 0°C während drei Jahren ohne mikrobiele Verschlechterung aufgespeichert worden.

Simulated Meat Fibres from Blood Plasma Proteins

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Blood plasma freeze-concentrated to a protein content of ca. 120 mg/ml., can be spun into meat-like fibres provided stable viscosity conditions are established (ca. 250P). Such stability may be achieved byfirst adding NaOH until the ratio of NaOH/protein is 1:10. This causes a marked increase to 50P in 15 minutes; following which acetic acid is added to reduce the pH from 12 to 11. The protein dope thus formed is pumped at 20-30 $lb.in.^{-2}$ into into a bath containing 20% NaCl in 1M acetic acid, forming fibres which can be withdrawn as a "tow" over godet wheels. High extrusion velocity from the spinnerets causes a greater degree of random aggregation of the protein in the fibres; whereas high withdrawal velocities tend to fracture the fibres.

The meat-like fibres produced have about 17% protein and 73% moisture. The ash content is high; but this can be reduced to that characteristic of lean meat by washing.

Fibres spun entirely from blood plasma proteins, although containing all the essential amino acids, tend to have a less than optimal content of isoleucine and methionine. This can be rectified by adding to the dope before spinning about 20% of proteins extracted by alkali from other abattoir waste such as lungs and stomachs. Provided the extraction of the latter is carried out below about 40°C little lysino alanine is produced.

As judged by rat-feeding trials, the spinning of such fibres enhances the net protein utilization in comparison with that of the original protein isolates, despite a slight lowering of the methionine content. The incorporation of some haemoglobin from the corpuscular fraction of the blood provides iron in absorbable form (thus conferring benefits over meat analogues prepared from vegetable protein); and helps to simulate meat colour.

The microbial status of the spun fibres is satisfactory. They have been stored at 0°C for three years without microbial deterioration.

H 3:2

La simulation de la viande fibreuse par les protéides du plasmasanguin.

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On peut file des fibres qui ressemblent à la viande après avoir concentrates le plasma du sang par la congélation à 120mg.protéide/ml. Pour cela on doit établir une viscosité stable(ca.250P) qu'on peut faire par l'addition de NaOH jusqu'à ce que NaOH/protéide soit 1:10. Il y a ainsi une augmentation rapide de la viscosité à 50P pendant 15 minutes. Maintenant on ajoute d'acide acétique pour réduire le pH de 12 á 11. On pompe, á 1.5-2.0 $kg.cm^{-2}$, le"dope"protéiné dans un bain dans lequel il y a 20% NaCl et 1 M d'acide acétique. Les protéides précipitent comme des fibres. On les retrouve audessus des roues "Godet".
Si l'on permet les protéides à entrer trop vite l'acide leur aggrégation fibreuse devient faite au hasard; et si l'on retrouve les fibres trop vite du bain, ils fracturent.
Ces fibres contiennent ca.17% de protéide et 73% de l'eau. Il y a aussi beaucoup de minéraux; mais on peut les diminue à niveau normal si l'on lave les fibres en l'eau. Dans les fibres qu'on file de plasmasanguin le niveau d'isoleucine et de methionine n'est pas le meilleur; mais on peut le corriger avant de filer par l'addition de 20% des protéides qu'on a extraitées par l'alcali des autres pertes d'abattoir e.g. les poumons et les estomacs. Les expériences avec la nourriture des rats démonstrent que la filature de ces fibres peut avancer le N.P.U. sur cela des extraits des protéides originales(quoiqu'il y a peu moins de methionine).
Si la temperature reste moins que 40°C il y a peu de lysinoalanine. L'addition de Hb fait les fibres même plus bonnes que celles fabriquées de protéides des legumes.
La condition microbienne de ces fibres est satisfaisante. On peut les retenir à 0°C pendant trois années avec de changement inappréciable.

Искусственное воспроизведение мясных волокон из белков кровяной плазмы

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Кровяная плазма сгущённая с помощью охлаждения до состояния при котором содержание белков достигает приблиз. 120 мг/мл. путем вращения может быть превращена в мясоподобную клетчатку в форме волокон, если будет обеспечены стабильные условия вязкости (приблиз. 250 р.) Такая стабильность может быть получена во-первых добавлением NaOH до тех пор пока состояние NaOH/белок не достигнет 1 : 10. Это вызывает заметное увеличение вязкости до 50 Р в течение 15 минут. Вслед за этим добавляется укусная кислота чтобы понизить pH с 12 до 11. Образовавшаяся таким образом белковая гуща перекачивается насосом, мощностью в 20-30 ф./кв. дюйм (14,500 - 22,000 Kg/m^2), в ванную, содержащую 20% NaCl в 1N укусной кислоты, формируясь в волокна, которые могут быть извлечены вытяжкой как "кудель", намоткой на колесах "годет". Высокие скорости выдавливания из давильников приводят к более высокой степени случайных агрегаций белков в волокнах, тогда как высокие скорости извлечения вытяжкой часто приводят к структурным разрывам в волокнах.
Полученные волокна содержат в себе около 17% белков и 73% влаги. Содержание минеральных веществ высокое, но оно может быть сокращено путём вымывания до уровня содержания минеральных веществ в нежирном мясе.
Волокна целиком произведенные из белков кровяной плазмы хотя и содержат все необходимые амино-кислоты, но в них часто случается, что содержание изолюцина и метионина бывает меньше оптимального. Это положение может быть устранено если добавить к гуще перед раскручиванием около 20% белков добытых методом экстакции с помощью щёлочи из других отходов на бойне, таких как лёгкие и требуха. При условиях когда экстракция последних производится при температуре ниже чем приблизительно 40°C производится немного лизино аланина Если судить по опытам с кормлением крыс, то производство таких волокон увеличивает прямую утилизацию белков по сравнению с первычными белковыми выделениями, несмотря на некоторое понижение содержания метионина. Включение некоторого количества гемоглобина из корпускулярной части крови обеспечивает волокна железом в легко поглащаемой форме,(создавая этим превосходство по сравнению с мясным аналогами, воспроизведёнными из растительных белков) и помогает имитировать цвет мяса.
Состояние микробов в накрученных волокнах - вполне удовлетворительное. Волокна сохранялись при темп. в 0°C в течение трёх лет без заметного ухудшения в состоянии микробов.

Simulated meat fibres from blood plasma proteins

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Introduction

The slaughter of cattle, sheep and pigs produces about 150,000 metric tons of blood annually in U.K. (Edwards, 1977). This includes 6,300 tons of blood plasma proteins or about 30,000 metric tons of meat equivalent, a total of some significance in relation to a total meat intake of about 2M metric tons. From time to time blood plasma has been considered as an exploitable source of nutrients for human consumers (e.g. as an egg albumen substitute : Brooks and Ratcliff, 1959); and, indeed, blood is used in making "black Puddings", haggis etc. in certain parts of the country. Nevertheless, most blood plasma in U.K. is wasted or severely underutilized. In the present day world such waste cannot be justified.

Recent Research at Nottingham

In recent years, proteins from plant sources (such as soya, field bean, wheat) have been extracted and spun or otherwise texturized into meat-like analogues (Boyer, 1954). Research in our laboratories, initiated 7 years ago, showed that fibres could be spun from blood plasma proteins; and that these could be gathered into paralled aggregates which closely ressembled meat in appearance (Young & Lawrie, 1974).

In attempting to apply a Boyer-type process to blood plasma, it proved necessary to partially freeze-dry it until the protein concentration was about 110-120 mg/ml. (Subsequently, freeze concentration was found more satisfactory than freeze drying : Swingler & Lawrie, 1977). A satisfactory degree of stability was achieved at a viscosity of 250 P by first adding NaOH (ratio NaOH/protein, 1:10). This initiated a swift increase in viscosity to 50 P 15 minutes, following which acetic acid was added to reduce the pH from 12 to 11. The protein "dope" thus formed was pumped at 1.5 - 2 Kg cm^{-2} through spinnerets into a bath containing 20% NaCl and 1M acetic acid, whereupon fibres of protein formed which could be gathered over Godet wheels. Such fibres contain 17% protein and 73% moisture (Young & Lawrie, 1974). The ash content is high (ca 8%); but this can be reduced to that characteristic of lean meat (ca 1%) by washing with water (Swingler & Lawrie, 1977).

The texture and mechanical properties of fibres spun from blood plasma proteins depends on a number of factors. Much reduced shear readings are obtained with high rates of extrusion of the protein dope from the spinnerets into the coagulating bath; and shear values are also lowered by high rates of fibre removal on the godet wheels (Young & Lawrie, 1975a). The composition of the coagulating bath also affects fibre texture : MH_2SO_4 produces a much coarser fibre than M acetic acid (Young & Lawrie, 1974). Again, the relative concentrations of acid and salt are important. Thus, 5% of NaCl and 5% of acetic acid are the minimum concentrations simultaneously required for fibre formation from a dope of blood plasma proteins. On the other hand, with 1% of NaCl, 10% of acetic acid is required (Swingler & Lawrie, 1977).

When using blood plasma proteins alone, it is relatively easy to produce fibres of satisfactory texture. Those prepared, in a similar fashion, from the proteins extracted from other offal such as lung, stomach and other portions of the digestive tract, however, tend to be brittle (Young & Lawrie, 1975b). By adding a

proportion of blood plasma proteins to these from the other sources before spinning, mixed protein fibres of satisfactory texture can be prepared (Young & Lawrie, 1975b : Swingler & Lawrie, 1978).

Fibres produced from the proteins of blood plasma or from those of stomach and rumen, are usually white in appearance. The incorporation of protein extracted from lung darkens the fibres in proportion to the amount added. This feature is beneficial in simulating meat colour, since the pigmentation thus incorporated is not readily removed (e.g. in subsequent cooking operations.

Whilst the incorporation of a relatively small proportion of blood plasma proteins enhances the external characteristics of fibres spun from other offal proteins, the latter also confer benefits in mixed fibres since their content of essential amino acids complements those of blood plasma proteins which tend to be relatively low in isoleucine and methionine (cf. Table 1 : Swingler & Lawrie 1978). Rat feeding trials confirm the chemical titres (Swingler, Neale & Lawrie, 1978). Indeed, there is some evidence that the biological value of fibres is rather greater than that of the proteins from which they are prepared. (Such is especially so in respect of fibres prepared from rumen protein - possibly because fibre formation excludes proteins in the original material which inhibit digestive enzymes).

A major problem which delays improved utilization of the proteins from meat by-products is the high level of microorganisms associated with the raw materials, and particularly with sources such as rumen, reticulum and other digestive tract material. From Table 2 it will be evident that the processes whereby proteins are spun, markedly reduce the number of psychrophils, mesophils and thermophils originally present (Swingler, Nayler & Lawrie, 1978). This is perhaps not altogether surprising in view of the acid and alkaline pH values, and the high salt concentrations, to which the proteins are exposed. Storage for 2 months at $0^{o}C$ produced no evidence for an increase in microbial numbers in any of the three categories; and, indeed, the spun protein-fibres - which have low pH - have been stored for 12 months at room temperature, and for 3 years at $0^{o}C$, without showing any gross deteriorative changes.

It remains possible that the spinning process, although associated with a vast reduction in microbial numbers (to the point of virtual sterility in the resultant fibres), could concentrate toxic proteins which had been formed by pathogens in the raw materials at an earlier stage; and which might well survive the preparative procedures. The rat feeding trials have shown no evidence for this; but the possibility requires further study - although blood plasma proteins, in contrast to those from other offal, are much less likely to be microbially contaminated initially.

We are currently investigating the functional properties of individual proteins, and groups of proteins, isolated from blood plasma; but since their intended use is not as fibres to simulate meat, this work will not be discussed here.

Conclusion

Much exploratory and developmental work is still required to identify the optimum procedures for producing organoleptically attractive products. Extrusion techniques including high pressure/high temperature treatment of the proteins would probably be cheaper than those involving spinning; but there might well be other disadvantages to offset this. Whichever approach is adopted, however, the need to upgrade currently wasted abattoir protein can scarcely be questioned.

TABLE 1. ESSENTIAL AMINO ACIDS COMPOSITION OF PROTEIN FIBRES SPUN FROM BLOOD PLASMA PROTEINS MIXED IN VARYING PROPORTIONS WITH THOSE EXTRACTED FROM LUNG OR RUMEN.

(Calculated)

% Composition of Protein Dope.		Arg.	Hist.	Isoleu	Lys.	Leu.	Met. (& Cyst.)	Phe/ Tyr.	Thr.	Try.	Val.
Plasma	Lung										
100	-	6.4	2.8	3.6	11.2	11.2	2.2	10.4	7.3	1.8	6.6
90	10	6.5	2.7	3.8	10.9	11.2	2.3	10.2	7.1	1.9	6.4
70	30	6.9	2.6	4.1	10.4	11.1	2.4	9.8	6.7	2.2	6.0
50	50	7.2	2.5	4.5	9.8	11.0	2.5	9.4	6.2	2.4	5.7
30	70	7.5	2.3	4.8	9.2	10.9	2.6	9.0	5.8	2.6	5.3
10	90	7.8	2.2	5.1	8.7	10.9	2.7	8.6	5.3	2.8	4.9
-	100	8.0	2.1	5.3	8.4	10.8	2.7	8.5	5.1	2.9	4.7
Plasma	Rumen										
90	10	6.5	2.7	3.8	10.9	10.9	2.3	10.1	7.1	1.8	6.3
70	30	6.7	2.5	4.1	10.4	10.4	2.5	9.6	6.5	1.8	5.7
50	50	6.9	2.3	4.4	9.8	9.9	2.6	9.0	6.0	1.7	5.0
30	70	7.1	2.1	4.7	9.3	9.3	2.8	8.5	5.5	1.7	4.4
10	90	7.3	1.9	5.0	8.8	8.8	2.9	8.0	5.0	1.6	3.8
-	100	7.4	1.8	5.2	8.5	8.5	3.0	7.7	4.7	1.6	3.5
FAO/WHO Recommended Score			4.0	5.5	7.0	3.5	6.0	4.0	1.0	5.0	

Table 2. Counts/gm of Raw Materials and Spun Protein Fibres

Source	Types of organism and incubation temperature		
	Psychrophils (7°C)	Mesophils (30°C)	Thermophils (55°C)
Raw Materials			
Plasma	(60)	1.7×10^2	(40)
Lung	6×10^2	1.7×10^4	(10)
Rumen	10^4	4×10^5	4.3×10^2
Spun Protein Fibres			
Plasma	(30)	3.5×10^2	(10)
Lung	(10)	(60)	(10)
Rumen	(20)	(40)	(10)

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