TABLE V

Viscoamylograph Curve Data and Gelation Properties of Legume Flours, Protein (PF) and Starch (SF) Fractions

	Peak viscosity, B.U.			Cold paste viscosity, B.U.			Degree of gelation, %		
	Flour	PF	SF	Flour	PF	SF	Flour	PF	SF
Soybean	60	---	---	60	---	---	0	---	---
Lupine	60	---	---	180	---	---	91	---	---
Chickpea	1,000	440	1,000	1,780	520	1,820	58	60	56
Pea bean	660	140	1,000	780	260	1,520	85	100	82
Northern bean	980	240	1,340	860	210	1,760	71	82	70
Fababean	460	60	700	1,020	150	2,260	74	92	59
Field pea	525	50	720	800	70	920	72	100	83
Lima bean	980	120	1,040	1,100	260	2,000	76	79	80
Mung bean	920	40	1,160	780	180	1,800	75	73	83
Lentil	640	80	980	840	260	2,400	77	95	53

showed stronger foam volumes than the flours, and only the stability of the field pea protein was poor. All protein fractions gave white foams, but the original slurries exhibited a range of colors from white to green-brown.

High peak and cold paste viscosities in the viscoamylograph curves were primarily a property of the starch fractions, and very low values were obtained for soybean and lupine flours as well as most protein concentrates (Table V). Intermediate peak viscosity values combined with high cold paste viscosity were characteristic of fababean and lentil starch fractions. Intermediate peak and cold viscosities were observed for field pea starch, while relatively high values for both parameters were obtained for northern bean starch.

Lupine flour showed good gelation properties, while the soybean flour developed into a thick pourable slurry during the heating and cooling experiment (Table V). Generally, the protein fractions tended to gel more completely than the starch fractions, but high values were obtained in both components. Pea bean and field pea proteins gelled completely while lentil and fababean proteins also gave high values.

Present data showed that a portion of the variation in functional properties among legume flours can be ascribed to the ratio of protein to starch, and other constituents such as lipids, in the original flour. In addition, the individual protein and starch fractions, even in the crude form obtained by air classification, exhibited a wide range in physiochemical characteristics. These air-classified products, possibly with future refining of the starch fraction, could serve to expand the range of functional raw materials available to the food and related industries. In general, food and industrial processors require ingredients with weak, intermediate or strong functional properties, depending on the end-use. Therefore, it is not appropriate to designate a particular air-classified fraction as being superior to another. However, it can be concluded that pea and northern bean, chickpea and lima bean flours, and air-classified fractions gave generally higher values in the functional property tests while fababean, field pea, mung bean and lentil gave high protein fractionation in the air classification process.

REFERENCES

1. Sosulski, F.W., M.D. Garratt, and A.E. Slinkard, Can. Inst. Food Sci. Technol. J. 9:66 (1976).
2. Sosulski, F.W., L.A. McLean, and H.M. Austenson, Can. J. Plant Sci. 54:247 (1974).
3. Youngs, C.G., "Oilseeds and Pulse Crops in Western Canada – A Symposium," Chap. 27, Western Cooperative Fertilizers Ltd., Calgary, Alberta, Canada, 1975.
4. Vose, J.R., M.J. Basterrechea, P.A.J. Gorin, A.J. Finlayson, and C.G. Youngs., Cereal Chem. 53:928 (1976).
5. American Association of Cereal Chemists, "Approved Methods of the AACC," Am. Assoc. Cereal Chem., St. Paul, MN.
6. Lin, M.J.Y., E.S. Humbert, and F.W. Sosulski, J. Food Sci. 39:368 (1974).
7. Inklaar, P.A., and J. Fortunin, Food Technol. 23:103 (1969).
8. Vose, J.R., Cereal Chem. 54:1141 (1977).

Taste of Potato Protein and Its Derivatives

K.H. NEY, Unilever Forschungsgesellschaft mbH, Hamburg, Behringstrabe 154, Germany

ABSTRACT

Large amounts of potato protein are available from potato processing plants. Nutritionally the amino acid composition is good, but the solubility of proteins recovered normally by heat coagulation needs to be increased. One way to do this is by enzymatic hydrolysis. Bitterness is thereby developed and this is discussed in relation to the Q value thesis.

In potato starch production, large amounts of potato protein become available as by-product and at the moment are mostly used only for animal feed.

There are several different ways of obtaining the protein from the processing liquor, the most economic being heat coagulation (1). For application in foodstuffs, the solubility of the protein has to be increased, and enzymatic hydrolysis seems to provide a good method of doing this. From a nutritional standpoint, potato protein has a very good amino acid composition and also has a high proportion of hydrophobic amino acids.

As previously described (2), the bitterness of a peptide is caused by the hydrophobicity of its amino acid residues. The mean hydrophobicity Q is obtained by summing the hydrophobicities of the different amino acid residues of a peptide and dividing by the total number of the residues, thus $Q = \frac{\Delta f}{n}$ Peptides with Q-values above 1,400 are bitter, whereas peptides with Q-values below 1,300 are not bitter (2-4). As an example: the dipeptide Glutamyl-lysine has a Q-value of $\frac{550 + 1,500}{2} = 1,025$ and is not bitter, 550 being the hydrophobicity increment for Glutamic acid and 1,500

TABLE I

Pancreatic Hydrolysis of Potato Protein

Time h	Amount of pancreatin ppm	Yield	α-N	Protein content	Taste
22	30.000	7.4 g	5.4 %	79.1%	bitter
17	30.000	7.3 g	5.5 %	80.4 %	bitter
6	30.000	6.8 g	5.5 %	81.7 %	bitter
5	30.000	6.3 g	4.5 %	82.9 %	bitter
2	30.000	5.5 g	4.1 %	83.0 %	bitter

TABLE II

Pancreatic Hydrolysis of Mixtures of Potato Protein and Gelatin

Ratio potato protein Gelatin	Amount of Pancreatin ppm	Time h	Taste
1:0	1,500	7	bitter
1:1	1,500	7	nonbitter
1:1	7,500	7	nonbitter
1:1	1,500	22	nonbitter
1:1	7,500	22	nonbitter

TABLE III

Pancreatic Hydrolysis of Mixtures of Potato Protein and Gelatin

Ratio potato protein/ gelatin	Taste	Solubility
1:1	nonbitter	v. sol.
2:1	nonbitter	v. sol.
4:1	nonbitter	v. sol.
6:1	bitter	v. sol.
10:1	bitter	v. sol.

the value for lysine. In contrast to this, Leucyl-tyrosine is a bitter tasting dipeptide having Q value of 2,645, the hydrophobicity for Leucine and Tyrosine being 2,420 and 2,870, respectively.

This Q value rule has been confirmed with more than 200 peptides, practically all peptides with known taste and structure obeying this principle (5). Furthermore, this principle is valid for peptides with molecular weights up to 6,000 Dalton as has been demonstrated by gel permeation chromatography (6); above this limit peptides with $Q >$ 1,400 are also not bitter.

Proteins are usually tasteless, but from their Q values a good indication can be obtained as to whether they have a tendency to produce bitter peptides during proteolysis: proteins with high Q-values are prone to produce bitter peptides by enzymatic treatment (2), whereas those with low Q-values are *not*.

Potato protein has the high Q value of 1,567 and consequently does tend to produce bitter peptides. For example, on attempting to increase the solubility of the potato protein by pancreatic treatment, a bitter tasting hydrolyzate was produced. Although the solubility was increased and coagulation did not occur on pasteurization, the bitter taste made this procedure inapplicable. Gel permeation chromatography revealed that mainly di-, tri- and tetrapeptides had been formed with molecular weights of ca. 200-400 Dalton. Nevertheless, a procedure has been described for the preparation of nonbitter hydrolyzates from any protein, characterized by the fact that the enzymatic hydrolysis is performed in the presence of gelatin (8). We (6) have found that, in this case, the formation of short chain peptides was largely inhibited, and we obtained "safer" products with molecular weights of above 6,000 Dalton. We applied this procedure to potato protein, and by pancreatic treatment of mixtures of potato protein and gelatin, we obtained fully soluble, nonbitter hydrolyzates which did not coagulate on pasteurization. Again, gel chromatography showed that the molecular weights of the peptides formed were largely above 6,000 Dalton. We varied the ratio of gelatin/potato protein and found that 4 parts potato protein to 1 part gelatin gave on pancreatic hydrolysis together a nonbitter hydrolyzate; whereas a ratio of 6 parts potato protein to 1 part gelatin resulted in a bitter product.

The accompanying tables give information related to the treatment of potato protein with pancreatic enzyme as summarized here: Table I on the effect of hydrolysis of potato protein; Table II and III on the effect of hydrolysis of mixtures of potato protein and gelatin; Table IV on the effect of such hydrolysis of 1:1 mixtures of potato protein and gelatin at 45 and 60 C.

TABLE IV

Pancreatic Hydrolysis of Mixtures of Potato Protein and Gelatin at Different Constant Temperatures

Ratio potato protein/ gelatine	Amount of pancreatin ppm	Time h	Temperature °C	Taste
1:1	7,500	7	45	nonbitter
1:1	7,500	22	45	nonbitter
1:1	11,250	7	45	nonbitter
1:1	11,250	22	45	nonbitter
1:1	7,500	7	60	slightly bitter
1:1	7,500	22	60	slightly bitter
1:1	11,250	7	60	slightly bitter
1:1	11,250	22	60	slightly bitter

ACKNOWLEDGMENT

Thanks are due to Dr. I.P.G. Wirotama for the enzymatic trials and to Dr. M. Unbehend for the gel permeation chromatography investigations.

REFERENCES

1. de Noord, K.G., Voedingsmiddelentechnologie, 8 (50):23 (1975).
2. Ney, K.H., Z. Lebensm. Unters. Forsch. 147:64 (1971).
3. Ney, K.H., 14. C.I.I.A. Symp. 1972, Saarbrücken, Proceedings bi D. Steinkopf, Darmstadt, 1974, S. 131.
4. Ney, K.H., IUFOST-Symp. 1973, Hamburg, Proceedings bei Butterworth, London, 1974, S. 411.
5. Guigoz, Y., J. Solms, Chem. Senses and Flavor 2:71 (1976).
6. Ney, K.H., DGF-Tagung Würzburg, 21.9.1977, Fette Seifen Anstrichm. 70:323 (1978).
7. Ney, K.H., Z. Unters.Lebensm.Forsch. 149:321 (1972).
8. German Patent Application 24 05 589 of AGFA-Gevaert.

Two Food Applications of Cottonseed Flours and Meals

T.S. DE BUCKLE, L.E. ZAPATA, G. SILVA, J.A. CABRERA, A.M. DE SANDOVAL, I. BEN-GERA, H. RIVEROS, and **I SHOMER**[1]

Instituto de Investigaciones Technológicas (IIT) Bogotá, Columbia

ABSTRACT

Procedures for preparing texturized cottonseed protein and isolate. In either case the free gossypol is effectively reduced. Further work is in progress especially on cottonseed protein isolate.

INTRODUCTION

Cottonseed meals and flours are often in excess in the local markets of tropical countries like Colombia (20,000 tons in 1974). Their use in human foods is restricted by well known factors, free gossypol and dark green color. Work has been done in Colombia and in many other places towards the economical elimination of these two drawbacks. Our results correspond to the work done at I.I.T., Colombia, on the production from commercial cottonseed meals of texturized vegetable protein through extrusion and on the production of 90% protein isolate using as extracting agent a hexametaphosphate solution.

TEXTURIZED VEGETABLE PROTEIN

In 1974 preliminary studies conducted at I.I.T. (1) showed that cottonseed flours could be texturized in a similar way to soybean flour, and that free gossypol contents were simultaneously reduced to safe levels. Further work done during the last few years has verified reduction in free gossypol, to evaluate the nutritional properties of the extrudate and the influence of the quality of the raw materials and processing conditions on the physical and textural properties of the extrudates.

Flours with different fiber, protein, and initial gossypol contents were run through extruders (Wenger X-5 and X-25) as seen in Table I, the extreme ones being flours C, and G (free gossypol and fiber). The extrusion variables studied were: die hole diameter, die type, flour/water mass ratio (2.65:8.30). Water pH (6.3, 7.0, 8.5, 10.0).

[1]Institute for Technology and Storage of Agricultural Products, Agricultural Research Organization, P.O. Box 6, Bet Dagan Israel.

Temperatures at the exit die were between 75 and 115 C in the X-5, and 103 to 135 C in the X-25. Product moisture at the exit die varied from 12.0 to 16.0% in the X-25 extruder. Methods used for chemical, physical and biological analysis were the conventional ones as described by Cabrera et al. (2) and Salazar- de Buckle et al. (3).

RESULTS

The results obtained showed it was possible to obtain a textured product with sensory characteristics similar to those of soybean texturized products as measured by the texture profile method (4). Scanning electron microscopy showed a structure (Fig. 1) similar to that of soybean T.V.P., rivulets, protein strands and their systematic layering as well as some spherical bodies that we believe may be intact protein bodies. Photomicrographs 1 and 2 correspond to soybean and cottonseed, respectively. Photomicrograph 3 we believe could be illustrating the strand formation through the elongation of one of the spherical bodies and shows another one already elongated that connects two layers of orientated protein fibers. Photomicrographs 4 and 5 show the fiber orientation observed, both in cottonseed and in soybean textured protein. In the cottonseed, a two dimensional layering which resembles that of bovine muscle tissues is observed, while in soybean the fibers or layers show a more complex interweaving. These seem to correlate with higher integrity indexes observed for soybean products.

Table II shows how the free gossypol content was lowered to levels below 0.020%. It also shows that high integrity indexes are correlated with low bulk density and high expansion indexes. The most appropriate water pH values were between 7.0 and 8.5.

Table III shows some data concerning the biological value of cottonseed extrudates compared with soybean TVP and whole hens' egg. The biological value obtained by using the slope ratio techniques (5) show similar results to those of the soybean-extruded product. The free gossypol

TABLE I

Chemical Analysis of Cottonseed Flours (Moisture Free Basis)[a]

Sample	Fat (%)	Crude fiber (%)	Protein (N x 6.25) (%)	Free gossypol (%)	Available lysine g/100 g protein
C	0.73	5.27	57.6	0.077	3.8
D	0.59	13.98	47.5	0.082	3.8
G	0.75	12.85	46.3	0.073	---

[a]Alkali Soluble protein (NaOH, 0.02 N) was 70.5 – 71.0 for all three samples.