milk, the ratio of albumin to casein is 20:80, while in maternal milk the ratio is 60:40. Here again, it is possible to use soy protein isolates in place of the globular protein casein.

In formulating such products, some specialists insist on a ratio of albumin to globular protein of 20:80, while others prefer the 60:40 ratio like that of maternal milk. The former base their preference upon the higher methionine content of casein, while the latter base their choice on the biological superiority of albumin over casein.

I believe we may conclude that soy protein isolates of high quality and nutritional value can be considered as a perfect answer to feeding, not only hypoallergenic cases, but also normal healthy infants. Continual research and development, combined with nutritional studies, will broaden the areas of application of soy protein isolates where nutrition is of the utmost importance.

Use of Soy Protein Isolate in Slimming Food

ERICH KOLB, Firma Peter Eckes, Nieder-Mainz, West Germany

INTRODUCTION

The value of a balanced diet, which meets nutritive physiological needs, is being recognized more and more. At a time in which an alarming increase in illnesses connected with nutrition is being recorded in most highly developed industrial nations, healthy food is becoming more and more important both for its prophylactic and its therapeutic value.

The development of foods aimed at preventing the consumption of superfluous calories is especially important in this respect. Today it is generally recognized that, in large portions of the populations of technologically highly developed countries, there is a tendency to overeat, which is often the main cause of illness and high mortality rates. According to the 1972 Nutrition Report, an average of 400-700 calories too many/head/day are consumed in the Federal Republic of Germany (1). The result is an increase in the frequency of overweight among all age groups. In the Federal Republic of Germany ca. 10% infants and children and ca. 30% of adults are overweight.

Numerous investigations show what an unfavorable effect overweight has upon humans. It does not only spoil the figure, but also can lead to severe injury to health. Thus, apart from frequent psychological trouble (2,3), an increase in premature general hardening of the arteries (arteriosclerosis) leading to accelerated pulsation and a rise in blood pressure can be detected among overweight people. Furthermore, there is often an accumulation of signs of diabetes mellitus, endogenous hypertriglyceridemia, gout, kidney stones, gallstones, inflammation of the pancreas, etc. Finally, the general resistance of infections is less in obese people. There is a clearly greater risk attached to operations for obese people than for people of normal wt (4).

These serious complications of obesity lead to a shorter life expectancy among overweight people—a fact which has been clearly established by the statistical investigations of large international insurance companies. Even in the case of moderate obesity, i.e. when the normal wt of the body is exceeded by 15%, a reduction of life expectancy by ca. 10% must be reckoned with (5), in the case of an overweight of 25% a reduction of 20%, and in the case of an overweight of 37% a reduction of 50% (6).

Avoiding or reducing excessive wt is, therefore, one of the most urgent requirements for the preservation of public health. All meaningful measures must be aimed at correcting the disproportion which exists between the intake and loss of calories by a diet which maintains the balance of one's energy—or, in the case of overweight—forms it negatively. The slimming foods offered by the food industry can be a valuable aid in this respect.

FACTORS INVOLVED IN SLIMMING FOOD DEVELOPMENT

Development of this kind of food requires a great deal of knowledge about the physiological functions of humans under extreme conditions, such as reduced calorie intake. The terrible experiences from both world wars give a comprehensive insight into the effects of malnutrition on large parts of the population.

Today we know that many of these phenomena were caused not only by an insufficient calorie consumption but also by a one-sided, substandard diet. Modern dietetics knows that efficiency, good health, and disease resistance of the organism require a diet which has a certain calorie content and a balanced relationship between protein, fat, and carbohydrates, as well as an adequate intake of vitamins, minerals, and trace elements.

An unbalanced diet, in which a nutrient is arbitrarily restricted, leads to symptoms of malnutrition. An insuffi-

TABLE I

Essential Amino Acid Composition of Various Proteins (g/16 g N)

Protein	Protein content percent	Isoleucine	Leucine	Valine	Methionine	Phenylalanine	Threonine	Tryptophan	Lysine
Whole egg protein	46	3.06	4.05	3.42	1.44	2.66	2.29	0.76	2.94
Yolk protein		2.00	2.67	2.18	0.81	1.40	1.61	0.46	2.09
Egg white protein		5.00	6.80	6.02	3.01	4.94	3.41	1.18	4.64
Na-caseinate	94	5.50	9.70	6.90	2.80	5.30	4.80	1.60	8.30
Skim milk powder	35	2.24	3.43	2.40	0.86	1.70	1.61	0.49	2.72
Fish protein	90	5.10	8.50	6.20	3.60	4.60	5.10	1.60	9.80
Seaweed protein	62-73	3.60	5.60	4.50	2.00	2.90	4.00	0.90	6.50
Milk yeast	47	2.10	3.49	2.48	0.57	1.77	2.78	0.60	3.41
Beer yeast	45	2.24	3.16	2.57	0.72	2.05	2.25	0.55	3.72
Isolated soy protein	90	4.60	8.10	4.60	1.00	5.50	4.00	0.90	6.60
Peanut protein		4.10	7.10	4.60	0.80	4.90	2.80	0.80	3.50
Cotton seed protein	65	2.60	5.70	4.50	1.40	5.60	3.10	1.20	4.10
Maize protein	73	3.50	7.30	5.90	1.90	4.50	3.80	1.30	6.30
Potato protein	88	6.30	10.50	7.40	2.20	6.90	6.20	1.30	8.40

cient protein content in the diet has an extremely injurious effect upon the health of man in the long run, because humans cannot form essential amino acids either from carbohydrates or from fat. Therefore, a lack of protein over a long period leads to a progressive protein deficiency with symptoms, such as anemia, muscular atrophy, skin changes, and reduction of reproductive powers (5).

If one considers these pathological reactions which occur in the case of insufficient protein intake, it is obvious that, when developing a healthy slimming food which meets nutritive physiological needs, special attention must be paid to the protein content.

Since the beginning of scientific food research, the question of how big the protein requirement of humans is, has been investigated. The shortage of protein, which still exists in many parts of the world, has concentrated attention upon the minimum quantity which must be fed to guarantee maximum efficiency. Several facts have been established.

To conserve the supply of functional body proteins, a quantity of protein which is sufficient to maintain an even nitrogen balance must be consumed, i.e. the intake and the loss of nitrogen must be equal. There is a minimum limit below which a nitrogen balance cannot be achieved any more. The organism then gets into a negative nitrogen balance, i.e. the loss becomes greater than the intake. The lowest level at which an even nitrogen balance still can be achieved is called the balance minimum.

The level of the balance minimum depends upon the biological value (BV) or on the protein efficiency ratio (PER) of the protein consumed. The BV is defined as the number of g body protein which can be replaced by 100 g of the food protein in question, while PER indicates the growth value, i.e. the wt increase/g available protein or protein-N (7). The PER tests mostly are carried out on rats, with a 10% protein intake (1.6% protein-N). Both BV and PER depend upon the essential amino acid content of the protein.

Most figures to be found in German technical literature fluctuate around 30 g, (4, 8-10) from which we may conclude that the relevant protein has BV of ca. 70 or a PER value of ca. 2.3. This daily balance minimum applies only for the healthy adult.

WHAT IS BEST PROTEIN SOURCE

The question arises as to which source of protein can best meet the quoted balance minimum requirement of 30 g protein/day, subject to a restriction of calories.

Thus, we must proceed from the fact that one has to make special demands of a protein which is to be used in an industrially produced, extremely low calorie slimming food. Our Minikal products, for instance, contain only 100-250 calories/meal. The protein which is to be used, must on the one hand satisfy the requirements of nutritive physiology and must, on the other hand, be flavorful and tasty. Finally, it is an established fact that food, which has a high health value, must be offered in such a way that taste, smell, color, and structure appeal to the consumer. It follows, therefore, that proteins, which are used in slimming food, have to meet the following requirements.

The protein used must be acceptable with regard to smell and taste. For nutritive physiological reasons it must have the highest possible BV or highest possible PER value. It should have the highest protein content possible and the proportion of non-protein type, calorie-containing ingredients should be as low as possible. Its color should be neutral. It must have good functional and physical characteristics. It should have good shelf life both as a raw material and as part of a finished product. Last, but not least, the protein should be as reasonably priced as possible.

During our development work, we attached great importance to selecting the protein which best fulfils all these requirements. Among those types of protein available in the Federal Republic of Germany which are suitable for human consumption, the following proteins were examined: full-cream milk powder, skim milk powder, Na- and K-caseinates, whey protein, whole egg protein, egg whites, potato protein, leaf protein, soybean protein, corn protein, cotton seed protein, miscellaneous types of yeast, fish protein, and blood plasma.

To ensure the most comprehensive choice possible, various quality products of various manufacturers were tested. While doing this, we aimed at catering with one meal for one-third of the daily minimum protein requirement, i.e. 10 g protein. During the individual tests, some of the listed proteins were discovered to be unsuitable, because of their taste or odor. The protein content of other protein raw materials was too low to make it possible to provide one-third of the minimum daily protein requirement, when subject to a calorie content of 100-250 calories/meal—the protein content/meal is a maximum 45 caloric %.

SOY PROTEIN ISOLATES

Upon examination of the listed protein raw materials we have concluded that soy protein and skim milk powder are the most suitable for our slimming food products. Soy protein isolates proved to be especially suitable for the reasons given below.

They have relatively acceptable sensory qualities, both as raw materials and as ingredients of our calorie-reduced end products. The peculiar bean type smell and taste, which often can be noticed in soybean protein products, is so limited in the isolate that its use is possible in weakly aromatic or lightly spiced products.

On account of their favorable amino acid composition soy protein isolates are among the most valuable nutritive physiological proteins (Table I).

As can be seen from Table I, the eight amino acids which are essential for humans are present in soy protein isolate in favorable proportions, as compared with other plant and animal protein materials. As Table I further shows, lysine content of soy protein isolate is relatively high. The content of this amino acid even exceeds that of whole egg protein. Thus soy protein isolate has a high supplementary protein value, especially in mixtures with lysine low grain proteins, such as wheat, oat, rye, and rice proteins.

The sulfur containing amino acid methionine with reference to the minimum daily need for amino acid of an adult man, is present in the smallest quantity in soy isolate. Methionine is, therefore, the limiting factor for the BV value of this protein.

As we know from feeding experiments with rats, the food value of soy protein isolate, measured by the increase in wt and by the PER values, can be improved significantly by the addition of small quantities of methionine. Thus, a PER value of 1.08-2.11 (margin) could be observed in rats, which, during a 4 week experiment, had received food which contained 10% isolated soy protein. Through the addition of only 1.5% methionine PER values of as much as 2.11-2.45 could be achieved (11). Thus, food value can be improved considerably by adding methionine.

In our experience, the addition of this synthetic amino acid to food, however, results in a loss in the taste quality of the finished product. This is especially noticeable in the case of bland products. Furthermore, the addition of methionine to food is not without complications in the Federal Republic of Germany. According to Section 4 of the West German Food Law, amino acids are to be regarded as foreign matter, because they are not protein, i.e. according to the peptid principle not condensed amino acids (12). Amino acids can be used in the production and preparation of food only under license.

Soy protein isolate contains up to 90% protein; the non-protein calories are very low and may be disregarded with respect to calories. For this reason, soy isolate is especially suitable for slimming food with an extremely low calorie content.

In selecting the proteins suitable for our products we also paid attention to color. Isolated soy proteins meet our color requirements well.

Soy protein isolate has good physical qualities which, from the functional point of view, are important for the preparation of food. Dispersion and suspension power are especially important. A further advantage is the relatively wide range of special soy protein types available. This means that they can be used in many ways, which makes it technically possible to adapt them to special requirements.

The storage qualities of the product are naturally important for the industrial manufacture of food. Consequently, great importance is attached to the investigation of the shelf life of our products. The storage tests of the packed products were carried out under normal conditions, i.e. at 20 C and at ca. 40% humidity, as well as at 4 C and ca. 55% humidity and at 38 C and ca. 90% humidity. At certain intervals the products were tested for taste, smell, and color. It was established that soy protein isolates, both as raw materials and as ingredients in our low-calorie end-products, have relatively good shelf life when correctly stored. Storage may be described as correct if there are normal room temperatures in the warehouse and if the products are exposed neither to direct sunshine nor high humidity but are stored in a cool, dry place.

REFERENCES

1. "Ernährungsbericht 1972," Deutsche Gesellschaft für Ernährung e.V., Frankfurt a.M., West Germany, 1973.
2. Gutezeit, G., Ernährungs-Umschau 10:346 (1972).
3. Aretz, H.H., H. Schulz, and G. Probst, Klin. Wschr. 49:125 (1971).
4. Holtmeier, H.H., "Diät bei Übergewicht und gesunde Ernährung," Georg Thieme Verlag, Stuttgart, West Germany, 1969.
5. Rapoport, S.M., "Medizinische Biochemie," Verlag Volk und Gesundheit, Berlin, West Germany, 1969.
6. Delauchaux, A., Rev. Med. Suisse Rom. 87:636 (1967).
7. Lang, K., "Biochemie der Ernährung," Bd. I, Verlag von Dr. Dietrich Steinkopff, Darmstadt, West Germany, 1957.
8. Lang, K., and O.F. Ranke, "Stoffwechsel und Ernährung," Springer Verlag, Berlin, West Germany, 1950.
9. Berg, G., and W. Fekl, Medizin und Ernährung 12:185 (1971).
10. Hegsted, D.M., "Proteins, Nutrition—A Comprehensive Treatise," Vol. I, Academic Press, New York, N.Y., 1966.
11. Meyer, E.W., in "Proceedings of International Conference on Soybean Protein Foods," ARS 71-35, United States Department of Agriculture, May 1967.
12. Zipfel, W., "Lebensmittelrecht," Bd. I, Stand 1, Verlag C.H. Beck, München, West Germany, 1973.

Protein Based Whipping Agents

J.W. MANSVELT,
Lenderink & Co. B. V., Schiedam, The Netherlands

INTRODUCTION

Aeration, the incorporation of a great number of small air bubbles into a food, transforms this food into a gas liquid dispersion, called foam or sponge. The air bubbles are surrounded by an extremely thin, but often tough, lamella and are usually small enough to be visible to the naked eye.

To create a foam structure, two requirements must be met: the composition to be aerated must contain a sufficiently large percentage of a *surface active agent*, and a sufficiently large amount of *energy* must be expended on the system.

SURFACE ACTIVE AGENTS

Surface active agents are substances characterized by the presence of hydrophobic and hydrophilic groups in the same molecule. Consequently, when present in dispersed systems, these molecules tend to concentrate in the interface between the two immiscible phases: oil-water, solid-liquid, and air-liquid. There, through specific orientation and possibly intermolecular bonding, stable two-dimensional network structures will develop that increase the stability of the dispersion. In the case of air-liquid dispersions (foams and sponges) the surface active agents are called whipping agents or aerating agents. They may be present in the original food (egg albumen in eggs), they may be formed during processing (protein derivatives in beer), or they may be added intentionally during the processing operation (egg albumen in the production of nougat or glycerol-monostearate in the case of cake batters).

To satisify food law requirements, whipping agents should preferentially be of natural origin. Proteins and protein derivatives find general application and such products as egg albumen and gelatin have been used traditionally. More recently, modified natural proteins of vegetable or animal origin, tailor-made to any specific application under strict laboratory control, are finding increased use. Being standardized to a high degree, they are better adapted to modern, continuous in-line processing.

BEATING OR WHIPPING

To supply the energy needed for the enormous expansion of the air-liquid interface that takes place during foam formation, mechanical means are used; and the operation is, therefore, called beating or whipping. The equipment used for this operation varies greatly: from the simple household wire whisk to big industrial in-line equipment. Aerating equipment can be designed for batch operation or for continuous processing and can be designed to operate under atmospheric pressure and to use air under increased pressure.

The process used for introducing aeration may be subdivided in two different systems that both have their advantages and disadvantages. In the one-step system all, or nearly all, of the ingredients used in the formula are mixed together and then whipped into a foam. In the case of the two-step system a part of the ingredients first is whipped into a light foam, while the rest of the ingredients are incorporated either as such or into a solution or a syrup. The use of the simple one-step system or the more complicated two-step system depends upon a number of factors, including moisture content and the presence or absence of fats, oils, or other foam inhibiting substances.

ADVANTAGES OF AERATION

The effects of aeration on the end product are two-fold. First, there is a definite improvement in quality. This is particularly noticeable in texture and consistency—smoother, less sticky, better eating characteristics, and better digestibility. In the second place, there is the effect of the density reduction.

In the case of foods sold as pieces or portions of a given wt, there is a volume increase that improves sales appeal. In