EFFECT OF MICROWAVE HEATING OF SOYBEANS ON PROTEIN QUALITY

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SUMMARY

The purpose of this study was to determine the protein quality of microwave cooked soybeans by the rat growth and protein efficiency ratio method (PER). It was found that properly cooked, dry, hulled, whole soybean seeds had a PER of 2.4 ± .06 (mean ± standard error) and a mean weekly weight gain of 21.2 ± 1.1 which were equivalent to 2.53 ± .10 and 18.3 ± 1.0 g for casein, respectively. These data demonstrate the value of microwave cooked soybeans and suggest further research on the possible economical and biological advantages of microwave cooked soybeans.

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INTRODUCTION

Efforts by Miller (1, 2) to improve the nutritional status of children and adults in the Orient led to the development and popularization of soybean beverages for the general populace. However, similar products have had little acceptance in the United States and other Western countries due to an objectionable "beany" flavor that develops rapidly after the bean is cracked and the enzyme lipoxygenase (3) comes in contact with oxygen in the air. In order to prevent the beany flavor from originating, a new method has been developed to inactivate the enzyme lipoxygenase in dry soybeans by microwave cooking prior to cracking the beans (4, 5). The result is a more bland tasting and smoother powder than has been heretofore produced and which is suited for its formulation into a beverage or for use in preparing other products. While microwave cooking inactivates the trypsin inhibitor (6), its effect on the nutritive value of soybeans is unknown. Therefore, the purpose of this study was to evaluate the effect on protein quality of microwave cooking of the dry whole soybean.

METHODOLOGY

Foods

The cooked soybeans used in these studies were a blend of Amsoy, Corsoy and Besson unhulled, dry, whole, seed soybeans that were irradiated in a continuous microwave cooker procedure which allows the beans to cook as they flow in the whole, dry state through the microwave heating chamber (4, 5). The mean cooking time for the beans of each sample was well within the 3 minute cooking time and temperatures required by Hamid, Barthia and Mostowy (6) to inactivate the trypsin inhibitor. The temperature of the beans as they left the cooking chamber ranged from 95 to 137°C for the various samples. The whole, irradiated beans were ground in an attrition mill and then pulverized in a mill (4). These powders and the subsequent formulated diets were maintained under refrigeration at a temperature of approximately 5°C. Standard methods were used for the analysis of the soybean samples (7). Casein served as the control protein, and raw soybean powder prepared as above was also fed to one group of animals.

Animals

Male weanling rats of the Sprague-Dawley strain were placed in individual stainless steel cages and allotted to diet groups of 10 animals each, and with a similar mean weight, after a three-day period of adjustment by feeding laboratory chow. Individual weight gain and individual food consumption were recorded weekly, and the protein efficiency ratio was calculated for a period of four weeks (7). The data were statistically analyzed by the Student's "t" test (8).

RESULTS AND DISCUSSION

Proximate Composition of Microwave Cooked Soybean Meal

The proximate composition of microwave cooked and raw soybeans used in this study is similar to the reported values (9) for soybeans (Table 1). The proximate composition of soybeans was not expected to change due to electronic cooking. The review on gamma irradiation with cobalt 60 by Lorenz and Miller (10) indicates that cereal grain composition is unaffected by irradiation, even though the latter may significantly alter the chemical structure of the protein, fat and carbohydrate and, thereby, its physical characteristics. Similar data for microwave cooking of soybeans are unknown. Also there is no information available as to the effect of microwave cooking of soybeans on their vitamin and mineral composition.

Biological Evaluation of Microwave Cooked Soybeans

Table 2 shows the effect of microwave cooking of whole soybeans on the rat weight gain and protein utilization. The casein used as control represents the pool of two groups of 10 animals per group. The conclusions derived from growth rate are essentially the same as those observed for the protein efficiency ratio (PER). All microwave heat treatments provide a protein quality that is significantly and progressively better than the raw soybean sample. Thus, the data show a direct relationship between heat treatment and protein quality as measured by growth and PER, i. e., the greater the heat treatment, the greater the growth rate and the PER. The latter is statistically similar for

TABLE 1

PROXIMATE COMPOSITION OF WHOLE SOYBEAN SAMPLES

Nutrients	Raw meal[a]	Microwave cooked meal[a,b]	Typical raw meal[c]
	o/o	o/o	o/o
Protein (N x 5.71)	36.3	37.2	37.6
Fat	22.1	23.1	20.0
Ash	4.1	4.6	5.0
Fiber	3.9	3.9	2.1
Carbohydrate	26.1	25.7	30.0
Moisture	7.5	5.5	7.4

a A blend of unhulled, dry, whole Amsoy, Corsoy and Besson seed soybeans.

b By continuous microwave cooking (4, 5).

c Leung and Flores (9).

both casein and soybeans subject to the highest heat treatment. Properly microwave cooked soybeans, therefore, have a protein quality similar to casein.

It is a well recognized fact (11, 12) that the protein quality of soybeans is inversely related to trypsin inhibitor. Consequently, it is of interest to note that Hamid, Barthia and Mostowy (6) have shown that increased temperature in microwave cooking of soybeans results in an increased destruction of trypsin inhibitor: 80o/o of the trypsin inhibitor was destroyed at 138°C and 100o/o was destroyed at 153°C. This increased destruction of the trypsin inhibitor by microwaves correlates with an improved protein quality found in our studies (Table 2) with microwave cooked soybeans up to 137°C. In contrast, under the present conditions, a high temperature of short duration made possible by microwaves, apparently did not thermally inactivate lysine (13), as is common by other more conventional methods, since the higher heat treatments did not decrease the protein quality.

TABLE 2

EVALUATION OF THE NUTRITIVE VALUE OF MICROWAVE COOKED WHOLE SOYBEANS BY THE GROWTH AND PROTEIN EFFICIENCY RATIO (PER) METHOD DURING A FOUR-WEEK PERIOD

Diet	Microwave cooker outlet temperature[a] °C	Weight gain			Protein efficiency ratio				
		g/week	Statistical difference compared to Casein	Statistical difference compared to Diet 11	Experimental	Statistical difference compared to Casein	Statistical difference compared to Diet 11	Corrected	°/o of casein
Casein	Ambient	18.3 ± 1.0[b]		NS	2.53 ± 0.10[b]		NS	2.50	100
Soybean[c]	Ambient	6.1 ± 1.4	<.01	<.01	0.92 ± 0.18	<.01	<.01	0.91	36
Soybean	95	7.6 ± 0.9	<.01	<.01	1.33 ± 0.08	<.01	< 01	1.31	53
Soybean	112	11.9 ± 0.7	<.05	<.01	1.79 ± 0.05	<.01	<.01	1.77	71
Soybean	115	12.7 ± 1.0	<.05	<.01	1.97 ± 0.10	<.05	<.05	1.95	78
Soybean	127	17.7 ± 1.0	NS	NS	2.18 ± 0.07	<.05	NS	2.15	90
Soybean	137	21.2 ± 1.1	NS		2.40 ± 0.06	NS		2.37	95

a By continuous microwave cooking (4, 5).
b Mean ± standard error.
c A blend of unhulled, dry, whole Amsoy, Corsoy and Besson seed soybeans.

Microwave cooking of soybeans in their dry, unprocessed state has definite advantages over cooking methods using water (11, 12) or where the bean is first fractionated. One consideration is the savings of transporting and storing a dry product rather than tons of water. Furthermore, the cost of cooking by microwave is lower (6). Prevention of the development of the "beany" flavor is an important consideration. The lipoxygenase that develops the "beany" flavor in soybeans (3) is effectively destroyed in the dry bean by microwave cooking before the "beany" flavor is allowed to develop (4, 5). The result is an organoleptically superior dry product with good quality protein. These relationships open wide the possibility of using the microwave cooking of soybeans, and suggest the need for further research.

CONCLUSIONS

The studies reported herein show that microwave cooking of whole soybeans provides a good-quality protein and makes possible the development of a bland-tasting dry powder that is an ideal base for use as a beverage or other products.

RESUMEN

EFECTO DE LA COCCION DEL FRIJOL SOYA POR MICROONDAS SOBRE LA CALIDAD DE LA PROTEINA

El propósito de este estudio fue determinar la calidad de la proteína del frijol de soya cocido por microondas, usando los métodos de crecimiento y del índice de eficiencia proteínica (PER) en ratas. Se encontró que la cocción adecuada de frijol de soya en su estado seco y entero tenía un PER de 2.40 ± .06 (promedio ± error estándar) y un promedio de crecimiento de 21.2 ± 1.1 g, los cuales son equivalentes a 2.53 ± .10 y 18.3 ± 1.0 g, respectivamente, para la caseína. Estos datos demuestran el valor del frijol de soya cocido por microondas y, además, sugieren la conveniencia de que se investigue las ventajas económicas y biológicas del uso de microondas para la cocción del frijol de soya.

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