STUDIES ON THE DEVELOPMENT OF INFANT FOODS FROM PLANT PROTEIN SOURCES. PART III. PREPARATION, PROCESSING AND PROPERTIES OF VARIOUS PRODUCTS DEVELOPED

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SUMMARY

Studies have been carried out on the development of a low-cost, high-quality infant food of low paste viscosity from rice, chickpea *(Cicer arietinum)* and cow's milk.

In order to improve the overall quality of the product, chickpea was processed by different methods prior to its incorporation. A number of formulations was prepared by mixing 52o/o rice, 30o/o each, the processed chickpea sample, and 18o/o whole milk powder. These mixtures were processed by extrusion cooking or drum drying. In the case of the extrusion cooking method, from the nutritional and technological points of view, it was found advantageous to incorporate milk powder after cooking a mixture of rice and chickpea. The values of net protein ratio (NPR) of the products developed, whether processed by extrusion cooking or drum-drying methods, were statistically equal, and not significantly different from those of casein. Supplementing the product with methionine and threonine showed no effect in improving the NPR value, suggesting that these amino acids were not limiting. There were slight differences in the digestibilities of proteins in the products developed and all were lower than that of casein. Depending on the processing method, differences were observed

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in paste viscosities of the products. After partial hydrolysis of the products with α-amylase, both the cold and hot paste viscosities were greatly reduced and were comparable with those of whole milk powder.

From the results herein reported, it can be concluded that the drum-dried product prepared using rice:chickpea (carbonate presoaked):milk (52:30:18) is the best of all the products developed. Its amino acid composition compares favorably with that of the milk proteins.

INTRODUCTION

It is now generally recognized that protein-calorie deficiency is one of the most widespread and serious hazards for the life and health of infants and young children in the lower income group of population in the tropical and subtropical regions of the world (1). The main reason for this deficiency is the scarcity and high prices of animal protein foods, particularly cow's milk, which can be used as a substitute for breast milk. In view of the fact that animal protein foods will eventually become difficult to obtain, despite efforts to increase dairying and stock-raising, several investigations have been carried out to utilize protein-rich foods of plant origin for combating protein malnutrition (2).

The complementary effect of essential amino acids between the proteins of cereals and legumes in improving their nutritive value, attracted the attention of nutritionists and food technologists throughout the world, to elucidate the possibilities of producing a nutritious product suitable for infants and young children. These researchers emphasized the importance of finding out the optimum ratio of cereal and legume proteins in order to achieve the best possible nutritional quality of the mixture (3-6).

Rice and chickpea were selected for product development in the present study, considering their availability in large quantities in Bangladesh, where the product is intended to be used. Although it is possible for a child to live and grow on an exclusively plant protein diet, it is preferable if some of the protein is of animal origin; it has been suggested that this should be as much as 25o/o of the total protein (1). Also from the acceptability viewpoint, combinations of animal and plant proteins are desirable.

Considering the work reported in the literature on the combination of cereals and legumes for improvement of their nutritive value, and in order to obtain a better essential amino acid pattern, 30, 40 and 30o/o of proteins from rice, chickpea and cow's milk, respectively, were used in the present food formulation. The minimum possible rice protein was used so as to maintain both the quality and quantity of proteins in the product.

Since processing of a good product is necessary for convenience of use, for increasing the palatability and stability of the products and for enhancement of nutritional quality, two comparatively cheaper processing methods such as simple extrusion cooking (7) and ordinary drum drying (8) are used with the aim of keeping the product cost relatively lower.

One of the major problems of using cereals and starchy legumes in infant or weaning food formulations is the thickness of the suspension when prepared for feeding, and it is not possible to feed even at a minimum level of the protein requirement per kilogram of body weight (9). Therefore, emphasis has been given in recent years to produce food of low paste viscosity. This can be accomplished by modifying starch particles by application of suitable processing conditions (10) or through partial hidrolysis of starch by α-amylase (11).

In previous papers of this series (12, 13), various processing conditions for improving the nutritional quality of chickpea proteins have been reported. The present communication describes the processing methods for production of infant foods of low paste viscosity using rice, chickpea and cow's milk, and evaluation of their chemical, physical and nutritive properties.

MATERIALS AND METHODS

Materials

Polished rice and chickpea used in this study were obtained on the open market in Guatemala City. A commercial whole milk powder was incorporated in the products developed. α-amylase[5] was procured from Sigma Chemical Company, USA.

Processing of chickpea. Chickpea was processed using three different techniques. A portion of the chickpea procured was dehulled using a Rural Industries Innovation Centre (RIIC) dehuller. The dehulled chickpea (cotyledons) were divided into two portions. One portion was soaked in water overnight (17-18 hr) at a temperature of 4-5oC. The water-presoaked (WP)chickpea cotyledons were boiled in water for 40 min and then dried in a hot-air oven at 70oC. The other portion of cotyledons was soaked in 1o/o sodium carbonate solution overnight (17-18 hr) at room temperature (27-29o/oC). The carbonate-presoaked (CP) chickpea cotyledons were processed according to the method described in an earlier communication (13). The processed cotyledons were dried under identical conditions as those used in the case of the water-presoaking procedure. A portion of the whole chickpea sample was allowed to germinate for two days under the conditions reported earlier (12). The germinated (g) chickpeas were dehulled by gently rubbing the seeds over an ironwire sieve, and the hulls were removed by floatation in water. The conditions of boiling the cotyledons and drying after boiling were similar to those used in the case of the water-presoaked method. The effects of these processes have already been informed (12, 13).

Product Development

a) By the extrusion-cooking method. Rice and processed chickpea cotyledons (WP) were ground into a coarse grit using a disc mill (The C.S. Bell Company, Hillsboro, Ohio). Five kg of rice and 2.86 kg of chickpea grits, representing the mixture between the two components with the highest protein quality, were mixed thoroughly in a liquid-solid blender (Patterson-Kelly Company, East Stroudsburg, PA, U.S.A.) for 10 min.

5 Bacterial crude type XI-A.

The mixed grits were then cooked in a Brady extruder (Koehring, Farm Division, Des Moines, Iowa) at a temperature of 250 - 260°F previously adjusted with whole soybeans. The cooked product was allowed to cool at room temperature and ground into a powder using a Raymond Screen mill No. 82, fitted with a 0.0031-inch mesh screen.

Eighteen grams of whole milk powder were added per 82 g of the cooked product and mixed thoroughly in a liquid-solid blender for 10 min. The mixture was partially hydrolyzed with α-amylase according to the method standardized by Hidalgo (11). After hydrolysis, the product was dried in a hot-air oven at 70°C and ground into a powder. A flow diagram of the procedure used for preparation of infant food using extrusion cooking is shown in Figure 1.

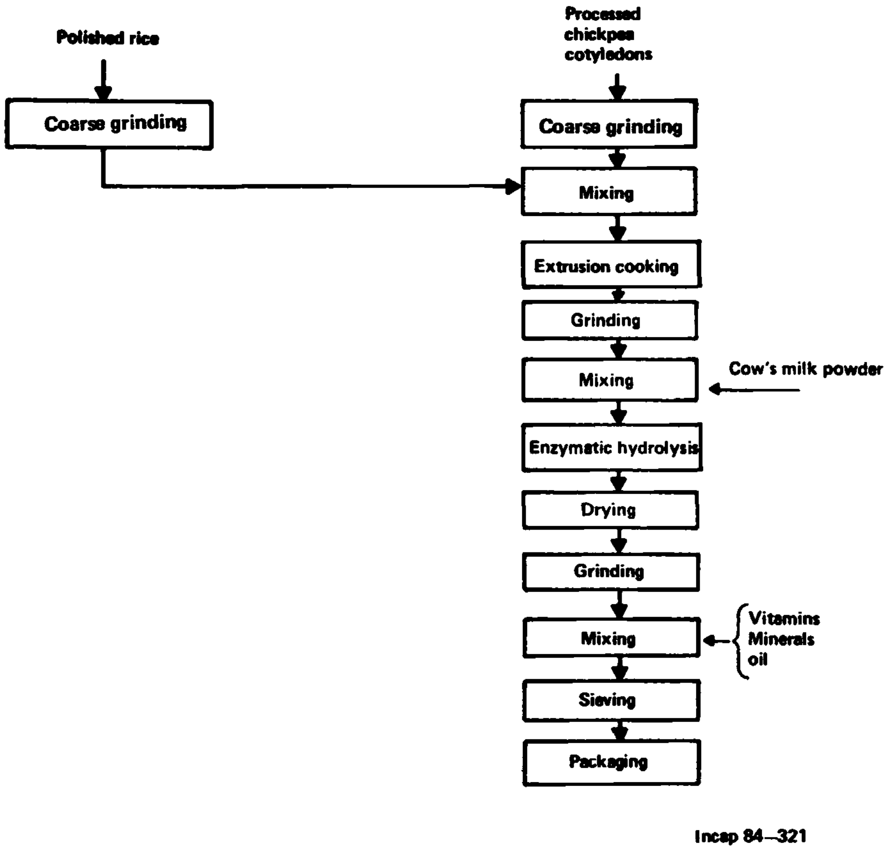

FIGURE 1

Flow diagram for production of infant foods using the extrusion-cooking method

b) By the drum-drying method. Rice and variously processed chickpea cotyledons were ground into a flour using a Raymond Screen mill. A thousand grams of rice flour, 572 g of chickpea flour and 344 g of whole milk powder were mixed together and a suspension was made by adding 7.5 liters of tap water. The suspension was cooked at a temperature of 65 - 70°C until a soft gel was formed, and then homogenized for 2 min using a Waring commercial blender (Dynamics Corp. of America, New Hartford, Connecticut). The cooked slurry was drum-dried on a double drum dryer (General Food Package Equipment Corp., Benton Harbor, Michigan), with a space setting of 0.004 inch between drums using steam pressure of 40 psig. The drum rotation was 6 rpm and the temperature on the drum surface during processing, 90°C. The rest of the procedure for preparing an infant food was similar to that used in the case of extrusion cooked products. Figure 2 is a flow diagram of the procedure used for production of drum-dried infant food.

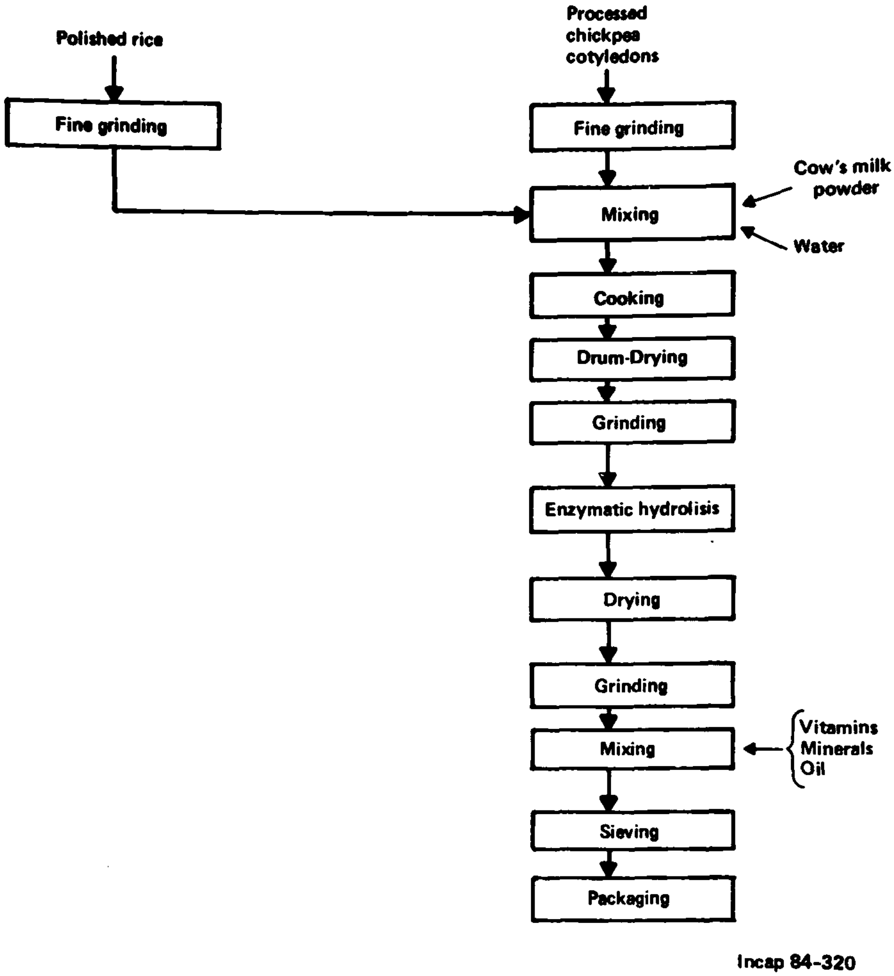

FIGURE 2

Flow diagram for production of infant foods using the drum-drying method

Chemical Analyses

Moisture, ash, fat and crude fiber were determined according to the standard method of the AOAC (14). The fat content in the products containing cow's milk was determined by the Majonier procedure (14). The nitrogen content was determined by the macro-Kjedahl method and the protein content calculated by using a conversion factor of o/o N x 6.25. The carbohydrate level was estimated by difference. Available lysine was assayed following the technique of Conkerton and Frampton (15) as modified by Carpenter (16).

Measurement of Viscosity

The viscosity was measured in a Saybolt viscometer (Precision Scientific, Chicago, Illinois) using fural orifice. When both the suspension preparation and determination of viscosity were carried out at room temperature (27oC), the viscosity was referred to cold paste viscosity, except in the case of the unprocessed mixture, where a suspension was cooked at 70-75oC for 5 min and cooled to room temperature prior to measuring the viscosity. Hot paste viscosity was determined by preparing the suspension at 65-70oC and measuring the viscosity at 40oC.

Color Measurement

The color intensity in the various infant foods developed was determined by using the Lovibond tintometer (The Tintometer Ltd., Salisbury, England).

Determination of Bulk Density

One hundred ml of each product were weighed and the weight was divided by volume. This was repeated three times in each sample and the average result was reported.

Biological Assays

Wistar strain rats from the INCAP's animal colony were used for these assays. At the beginning of the experiment, each rat (21 days old) was weighed and animals were then distributed in different groups, consisting of 4 males and 4 females per group. The average weight of rats in one group did not differ from that of the other group by more than ± 0.5 g. The rats were housed individually in metal cages with raised wire mesh screen bottom. The experimental diets contained the protein foods at a level to provide 10o/o protein (60.5 - 62.6o/o) and mineral mix 4o/o (17), cottonseed oil 5o/o, cod liver oil 1o/o and cornstarch to adjust to 100o/o. One of the diets containing the high-quality mixture of rice/chickpea (WP/milk was supplemented with 0.2o/o methionine and 0.1o/o threonine. Casein was used as protein source in the control diet. One diet was free from nitrogenous constituents, and each diet was supplemented with 5 ml of a vitamin solution (18).

The experiment was conducted for a period of 10 days for the determination of NPR of the different test materials. The digestibility of proteins was determined during a 5-day period after the NPR trial using the procedure described earlier (13).

Amino Acid Analyses

Analyses for amino acid content were carried out using a Technicon amino acid analyzer from an acid hydrolysate.

RESULTS AND DISCUSSION

The proximate composition of various infant foods developed was essentially the same. On the average, it contained 3.4o/o moisture, 16.2o/o protein, 5.1o/o fat, 1.1o/o crude fiber, 1.3o/o ash and 72.8o/o carbohydrate. Since all of the products except one contained equal amounts of either rice, chickpea or milk, their compositions were very similar whether processed by extrusion-cooking or drum-drying methods. The product prepared by using rice and chickpea only gave slightly lower fat and ash values and slightly higher fiber content compared with those in the products containing cow's milk.

It has been known that during heat processing of a protein food containing carbohydrate, a reaction may take place between the E-amino groups of lysine and aldehyde groups of carbohydrate, affecting the availability of lysine and the color of the product. The results shown in Table 1, reveal that under the processing conditions used, drum drying has no significant effect in making the lysine unavailable and on darkening the color of the product. Nevertheless, an appreciable loss of available lysine was observed in the extrusion-cooked product when milk powder was added prior to processing. It was therefore decided to incorporate milk in the product after extrusion cooking a mixture of rice and chickpea grits (Figure 1).

TABLE 1

EFFECT OF ADDITION OF COW'S MILK POWDER TO THE BASIC INGREDIENTS PRIOR TO PROCESSING, ON THE AVAILABLE LYSINE AND THE COLOR OF INFANT FOODS
(Rice:chickpea (WP):milk, 52:30:18)

Processing method	Addition of cow's milk	Lysine g/16 g N	Lovibond tintometer color description	
			Yellow	Orange
Drum drying	Before processing	6.18	0.5	0.0
Drum drying	After processing	6.22	0.4	0.0
Extrusion cooking	Before processing	5.74	1.1	0.9
Extrusion cooking	After processing	6.17	0.6	0.3

The various infant foods developed were analyzed for their available lysine contents. Results demonstrate that the availability of lysine (average 6.1 g/16 g N) in any of the products is higher than that recommended in the FAO/WHO reference pattern (See Table 3).

Table 2 presents the findings of the determination of net protein ratio (NPR) of various infant food preparations. Statistical analysis of the data

TABLE 2

NUTRITIVE VALUE OF PROTEINS IN VARIOUS INFANT FOOD PREPARATIONS

Infant foods	Protein in diets	Average diet intake (g)	Average weight gain g/10 days	Net protein ratio (NPR)*
Simple mixture rice:chickpea (WP):milk (52:30:18)	10.30	106.25	35.37	3.87 ± 0.31
Extrusion cooked rice:chickpea (WP) (50:50)	9.95	98.00	31.12	3.91 ± 0.37
Extrusion cooked rice:chickpea (WP):milk (52:30:18)	9.78	98.25	33.87	4.27 ± 0.19
Drum-dried rice:chickpea (WP):milk (52:30:18)	10.00	98.50	33.87	4.16 ± 0.48
Drum-dried rice:chickpea (WP):milk (52:30:18) digested**	10.01	96.00	34.00	4.28 ± 0.37
Drum-dried rice:chickpea (WP):milk (52:30:18) supplemented***	10.08	107.87	34.75	3.81 ± 0.41
Drum-dried rice:chickpea (CP):milk (52:30:18)	9.87	97.00	33.87	4.28 ± 0.23
Drum-dried rice:chickpea (G):milk (52:30:18)	9.99	97.00	33.37	4.18 ± 0.34
Casein	10.18	99.25	36.12	4.28 ± 0.26

* The NPR values are not significantly ($p > 0.05$) different from each other (Mean ± SD).

** Digested with α-amylase.

*** Supplemented with methionine 0.2% and threonine 0.1%.

indicates that none of the NPRs is significantly lower than that of casein. However, a slight improvement of nutritional quality occurred when a simple mixture of rice:chickpea:milk (52:30:18) was processed by the drum-drying method. The NPR of the extrusion–cooked product containing milk powder is slightly higher than that of either the unprocessed mixture with the same composition, or the product prepared without milk. The predigestion with α–amylase had a slight beneficial effect in improving the nutritive value of the protein, whereas supplementation with methionine and threonine gave a bit lower NPR value. It is probable that methionine and threonine are not the limiting amino acids in the test product, and were added on the basis of theoretical calculations.

The apparent and true digestibilities of the proteins in various infant foods developed and those of casein are shown in Table 3. As the results indicate, digestibility of the proteins in all the products is statistically equal and significantly lower than that of casein. The digestibility coefficient of proteins in the product prepared using carbonate-presoaked chickpea was found a little higher, compared to that obtained in the case of the product prepared using either germinated or water-presoaked chickpea. The protein digestibility in the supplemented diet was slightly lower than that of the protein in the unsupplemented one. This is due to interference in the absorption of amino acid by the higher amount of methionine used in supplementation.

The physical properties of the infant foods developed were studied and the results are compared in Table 4 with those obtained from a commercial weaning food and a commercial whole milk powder. According to the data, bulk densities of the products prepared either by extrusion cooking or drum drying and that of the commercial weaning food are almost equal. It can be observed that the bulk density of a mixture of rice:chickpea:milk (52:30:18) is reduced during processing, probably as a result of expansion of the protein and starch particles. Results of measuring the intensity of color indicate that the yellow color of the chickpea flour predominates in a mixture of rice, chickpea and milk. But after cooking this mixture and drum drying the cooked slurry, the yellow color is greatly reduced, probably due to intimate mixing at the molecular level of the yellow chickpea flour and white rice flour. The extrusion cooked products were light brown in color. The variation of the color intensity in different drum-drying products is caused by the variation of color of the chickpea flours used (13). The data also indicate that the color of the drum-dried product prepared from a mixture of rice:chickpea (CP):milk (52:30:18) is very similar to that of a commercial whole-milk powder. The commercial weaning food analyzed was dark brown, color which developed presumably either during processing or by adding a coloring matter.

Processing of a mixture of rice:chickpea (WP):milk (52:30:18) by drum drying caused a decrease in cold paste viscosity of a suspension at 10o/o solid level (Table 4). The suspension, prepared from the unprocessed mixture at the same solid level, was too thick to measure the viscosity in a Saybolt viscometer; consequently, a suspension with lower solid content was prepared for the purpose. The suspensions prepared from the drum-dried infant foods containing either carbonate-presoaked or germinated chickpea were less viscous, in comparison to those products

TABLE 3

AVAILABLE LYSINE AND DIGESTIBILITY OF PROTEINS IN VARIOUS INFANT FOOD PREPARATIONS

Infant foods	Available lysine g/16 g N	Apparent digestibility AD	True digestibility TD
Simple mixture rice:chickpea (WP):milk (52:30:18)	6.44	$77.10^{b} \pm 1.63$	$79.51^{b} \pm 1.55$
Extrusion cooked rice:chickpea (WP)	5.68	$75.06^{bc} \pm 1.05$	$77.75^{bc} \pm 0.91$
Extrusion cooked rice:chickpea (WP): milk (52:30:18)	6.08	$75.81^{bc} \pm 1.62$	$78.82^{bc} \pm 1.89$
Drum-dried rice:chickpea (WP):milk (52:30:18)	6.24	$75.26^{bc} \pm 20.4$	$78.78^{bc} \pm 1.87$
Drum-dried rice:chickpea (WP):milk (52:30:18), digested*	–	$75.94^{bc} \pm 1.66$	$78.88^{bc} \pm 1.77$
Drum-dried rice:chickpea (WP):milk (52:30:18) supplemented**	–	$73.89^{c} \pm 2.04$	$76.51^{c} \pm 1.94$
Drum-dried rice:chickpea (CP):milk (52:30:18)	5.91	$76.31^{bc} \pm 0.61$	$78.93^{bc} \pm 0.64$
Drum-dried rice:chickpea (G):milk (52:30:18)	6.07	$75.49^{bc} \pm 1.73$	$78.10^{bc} \pm 1.61$
Casein (control)	–	$82.37^{a} \pm 1.29$	$85.09^{a} \pm 1.17$

* Digested with α-amylase.

** Supplemented with methionine 0.2o/o and threonine 0.1o/o.

In each vertical column, means carrying the same superscript are not significantly ($p > 0.05$) different (Mean ± SD).

prepared using water-presoaked chickpea under identical conditions. The extrusion-cooking method was found to be more effective in reducing the viscosity of the resulting product. Desikachar (10) also found a marked

TABLE 4

PHYSICAL PROPERTIES OF THE VARIOUS INFANT FOODS DEVELOPED

Infant foods	Bulk density	Lovibond tintometer color description		Cold paste viscosity* (cps)
		Yellow	Orange	
Simple mixture rice:chickpea (WP):milk (52:30:18)	0.62	0.9	0.0	27.97**
Extrusion cooked rice:chickpea (WP) (50:50)	0.53	0.5	0.4	34.52
Extrusion cooked rice:chickpea (WP):milk (52:30:18)	0.55	0.4	0.3	22.40
Drum-dried rice:chickpea (WP):milk (52:30:18)	0.56	0.5	0.0	31.60
Drum-dried rice:chickpea (CP):milk (52:30:18)	0.56	0.3	0.0	25.56
Drum-dried rice:chickpea (G):milk (52:30:18)	0.55	0.2	0.0	25.56
A commercial weaning food	0.56	0.1	0.8	51.11
A commercial whole milk powder	0.59	0.3	0.0	—

* At 10o/o solid content.
** At 7o/o solid content.

variation in the paste viscosity of rice and chickpea when processed by different methods.

The effect of partial hydrolysis of the products developed with α-amylase on the cold and hot paste viscosities was studied, with the results shown in Table 5. According to the data, the cold paste viscosities of the suspensions prepared from the hydrolyzed products at a 15o/o solid level are similar to, or in some cases, lower than those obtained at 10o/o solid level in the case of unhydrolyzed products (see Table 4). The hot paste viscosities of the three drum-dried products were found equal and slightly higher than those of the extrusion-cooked product and of whole-milk powder.

TABLE 5

EFFECT OF ENZYMATIC HIDROLYSIS ON THE PASTE VISCOSITY OF VARIOUS INFANT FOODS DEVELOPED (AT 15o/o SOLID LEVEL)

Infant food	Cold paste viscosity (cps)	Hot paste viscosity (cps)
Extrusion cooked rice:chickpea (WP):milk (52:30:18)	8.89	4.60
Drum-dried rice:chickpea (WP):milk (52:30:18)	37.81	8.89
Drum-dried rice:chickpea (CP):milk (52:30:18)	20.95	8.89
Drum-dried rice:chickpea (G):milk (52:30:18)	13.28	8.89
A commercial whole milk powder	31.35	4.60

On the basis of chemical, physical and nutritive properties, the drum-dried product prepared from rice:chickpea (CP):milk (52:30:18) was considered to be the best one and, therefore, its amino acid pattern was determined. Results are shown in Table 6, in comparison with the amino acid composition of whole milk powder and of the product prepared without milk in the present study and the FAO/WHO reference pattern. As the data indicate, incorporation of cow's milk in the product resulted in a better balance of essential amino acids. The ratio of the essential to non-essential amino acids of the proteins in the product considered, are very similar to that of whole milk protein. The difference between the test sample and the FAO/WHO pattern in regard to the methionine and threonine content is not reflected in the protein quality evaluation carried out by biological assay. Therefore, this small deficiency, as compared to FAO/WHO pattern, should not be considered critical from the practical point of view.

As the results showed, the mixture of 52:30:18, rice:chickpea:milk, is of high quality, particularly that produced by drum drying.

TABLE 6

COMPARISON OF AMINO ACID COMPOSITION OF THE INFANT FOODS DEVELOPED, WITH THAT OF WHOLE MILK PROTEIN AND FAO/WHO (1973) AMINO ACID REFERENCE PATTERN (g/16 g N)

Amino acids	Rice:chickpea (WP) (50:50)	Rice:chickpea (CP):milk (52:30:18)	Whole milk* protein	FAO/WHO pattern
Lysine	5.52	6.11	7.94	5.0
Threonine	3.02	3.20	4.70	4.0
Valine	4.64	4.16	7.00	5.0
Total S-amino acids	–	–	3.41	3.5
Methionine	1.38	1.34	2.50	–
Isoleucine	7.58	6.98	6.51	4.0
Leucine	6.98	6.72	10.02	7.0
Total aromatic amino acids	7.62	6.82	10.14	6.0
Tryptophan	–	–	1.44	1.0
Total essential amino acids	36.74	35.33	53.66	35.5
Histidine	2.58	2.70	2.69	
Arginine	9.70	7.60	3.73	
Aspartic acid	7.82	5.63	7.44	
Serine	3.39	3.18	6.02	
Glutamic acid	11.95	9.71	23.86	
Proline	4.46	4.26	11.34	
Glycine	3.18	2.53	2.02	
Alanine	4.14	3.04	3.52	
Total non-essential amino acids	47.22	38.65	60.62	
Essential AA / Non-essential AA	0.78	0.91	0.81	

* Reference 20.

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RESUMEN

ESTUDIOS SOBRE EL DESARROLLO DE ALIMENTOS INFANTILES CON BASE EN FUENTES DE PROTEINA VEGETAL. PARTE III. PREPARACION, PROCESAMIENTO Y PROPIEDADES DE VARIOS PRODUCTOS DESARROLLADOS

Se han llevado a cabo estudios para el desarrollo de un alimento infantil de bajo costo y de alta calidad, de consistencia de pasta de baja viscosidad, a base de arroz, garbanzo *(Cicer arietinum)* y leche de vaca.

Con el propósito de mejorar la calidad del producto, se procesó el garbanzo por diferentes métodos antes de incorporarlo a la mezcla. Se prepararon varias fórmulas mezclando 52o/o de arroz, 30o/o de cada muestra de garbanzo procesado y 18o/o de leche entera en polvo. Estas mezclas fueron procesadas por extrusión o deshidratación mediante secado por tambor. En el caso del método de cocción por extrusión, desde los puntos de vista nutricional y tecnológico, se encontró ventajoso incorporar la leche en polvo después de cocer la mezcla de arroz y garbanzo. Los valores de razón proteínica neta (NPR) de los productos desarrollados, ya fuese procesados por extrusión o por deshidratación mediante secado por tambor, fueron estadísticamente iguales y no difirieron significativamente de los de caseína. La suplementación del producto con metionina y treonina no tuvo ningún efecto en cuanto a mejorar el valor de NPR, lo que sugiere que dichos aminoácidos no eran limitantes. Hubo pequeñas diferencias en la digestibilidad de las proteínas de los productos elaborados, siendo todos ellos de más baja digestibilidad que la de caseína. Se observaron algunas diferencias en las viscosidades de las pastas de los productos, dependiendo del método de procesamiento. Después de la hidrólisis parcial de los productos con α-amilasa, las viscosidades tanto de la pasta fría como de la caliente, se redujeron notoriamente, siendo comparables con las de la leche entera en polvo. A partir de los resultados señalados, es factible concluir que el producto deshidratado mediante secado por tambor y preparado con arroz:garbanzo (remojado previamente en carbonato):leche (52:30:18) es el mejor de todos los productos elaborados. Su composición de aminoácidos compara favorablemente con la de la proteína de leche.

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