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| 1. SUBJECT CLASSIFICATION | A. PRIMARY Public Health |
| | B. SECONDARY Nutrition |

2. TITLE AND SUBTITLE
 Critical evaluation of new or enriched protein sources for the prevention of malnutrition, progress report on spray dried soy-whey-formulation

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|--------------------------|----------------------------|----------------------|
| 4. DOCUMENT DATE 1973 | 5. NUMBER OF PAGES 9 p. | 6. ARC NUMBER ARC |
|--------------------------|----------------------------|----------------------|

7. REFERENCE ORGANIZATION NAME AND ADDRESS
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8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

9. ABSTRACT

The limited number of studies with this product gave such consistently good results that it can be stated confidently that the soy-whey mixture is an excellent source of dietary protein. Despite moderately inferior nitrogen absorption, probably attributable to the soy flour, the retentions were the equal of those from casein. In all of the studies there was a consistent tendency for serum albumin to fall off slightly during the Mx-37 dietary periods. This is consistent enough to be significant, although in most cases the serum albumin still remained in the normal range. This probably is due to the fact that the mixture undoubtedly has methionine as its first-limiting amino acid. If it provides at least 8% of calories as protein, this product can be recommended as the only source of protein in the diet of infants and children.

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| 10. CONTROL NUMBER PN-AAC-578 | 11. PRICE OF DOCUMENT |
| 12. DESCRIPTORS Food mixes Milk Proteins Soy supplement | 13. PROJECT NUMBER |
| | 14. CONTRACT NUMBER CSD-2946 Res. |
| | 15. TYPE OF DOCUMENT |

AM

612.382
5734A
CSD-2946 RES
PN-AAC-578

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SUBJECT: Progress Report - June 20, 1973
Research Contract AID/csd-2946
Critical Evaluation of New (or Enriched)
Protein Sources (For the Prevention of
Malnutrition)

Spray Dried Soy-Whey Formulation

1p.

The spray dried soy-whey formulation which is the subject of this report was submitted to us for evaluation by the Food Conservation Division of UNICEF and identified by their code Mx-37. It was made available to them by the Eastern Utilization Research and Development Division of the Agricultural Research Service of the United States Department of Agriculture and identified as S-12. Its processing was described as follows: "Twenty-five pounds of full fat soy flour were added to 735 pounds of sweet whey of 6.83% T.S. The mix was pasteurized at 170°F for 20 seconds and then homogenized at 5,000 plus 500 p.s.i. It was then passed through a Mallory heater at 140°F and concentrated two times in vacuo at 26.5" vacuum in a falling film evaporator, coming out of the pan at 121°F each time. The concentrate was standardized to 44% T.S., 19.50 Baume. It was then spray dried using a 0.030 nozzle at 2,600 p.s.i. with a feed rate of 8.5 lb./min. A Grey-Jenson Spray Dryer was used. Intake temperature was 278°F and the exhaust temperature was 200°F."

This product is a one-third soy solids, two-thirds whey solids product with about 8.0% fat and 22% protein. Its PER as obtained was 2.47±0.09 (standardized 2.14). The value for casein was 2.88±0.06. Its NPU was 84.

This product was used as the only source of protein in the diet of five convalescent malnourished or normal infants. In three of the infants, comparisons were made between the product (Mx-37) and casein as the source of protein. In the

remaining two infants the product was fed as the only source of protein for periods of 4.6 and 4.7 months respectively. At the end of this prolonged feeding a comparison was made with casein. We thus have five comparative and two prolonged studies. In three of the comparative studies casein was given before and after the test product and in the other two, casein was given only after the test product.

In both the comparative and prolonged studies enough sucrose and cottonseed oil were added to the diet to make fat and carbohydrate supply approximately 50% each of the non-protein calories. A complete vitamin and mineral mix was added daily in all studies. Protein and calorie intakes were recalculated daily on the basis of actual body weight.

Results

The mixture containing Mx-37 as the source of protein was well taken by all five infants. Because of its high lactose content we were not surprised to find some loose stools in the oldest child, #190, a normal boy. This was never severe enough to cause any serious problem in his case

Table I summarizes the results obtained in comparative studies. The first child, #196, a boy, recovering from malnutrition received Mx-37 as the only source of protein for 30 days, preceded and followed by nine days on casein. At all times protein provided 8% of calories. During the first three days on Mx-37 the retention of nitrogen was very poor but this soon increased and was maintained at a rate at least

equivalent to that from casein. Apparent absorption of nitrogen was approximately 74% of intake from Mx-37 as against an average of 81% from casein. Rates of weight gain were not significantly different and although serum albumin fell moderately during the 30 days on Mx-37, it remained at a high normal level. On the basis of this study in this child one might say that the soy-whey mixture, despite moderately inferior digestibility, was at least the equivalent of casein in biological value.

In the second child, #198, a boy also convalescing from malnutrition, the study was made at much more critical levels of intake. During the first ten days he received 5.3% of total calories as protein from casein and during the following 14 days from Mx-37 at the same levels. During the following 23 days, still on Mx-37, total calories were reduced so that 6.4% of calories came from protein. This was followed by nine days on casein at similar levels. The absorption of nitrogen in this child was again slightly inferior for Mx-37, 76.5% of intake as against 80.5% from casein. The retention of nitrogen from Mx-37 was at least the equal of that from casein, if not better, while the rate of weight gain was again not significantly different. At 5.3% of calories as protein the serum albumin fell moderately but at 6.4% of calories it recovered. The fall during the final casein period may represent a sub-clinical infection, as there was simultaneously a fall in the rate of weight gain. Again from this study one

must conclude that in this child, Mx-37 was at least the equal of casein in biological value.

In the third infant, #202, a boy recovering from malnutrition, both casein and Mx-37 provided 6.4% of calories as protein. Apparent absorption of nitrogen was 86% of intake from casein, 81% of intake from Mx-37. Retentions of nitrogen were similar on both products, as was the rate of weight gain. There was a slight fall of serum albumin during the 30 days on Mx-37 but at the conclusion of this period it was still in the normal range. Again the biological value was apparently at least as high as that of casein.

The remaining two children, both normal, had comparisons made at the end of prolonged feeding. In #199 absorption of nitrogen was lower from Mx-37 but the retentions were identical. Again there was a fall in serum albumin during the Mx-37 period. In #190 the protein intake from Mx-37 was decreased for eight days in order to make a more valid comparison with casein. Although absorption and retention of nitrogen had been quite high during the initial 14 days they fell when protein was reduced. There was also a loss of weight during this time. It is possible that this is merely the effect of a reduction in protein intake, with not enough time having been allowed for nitrogen excretion to fall to a new level. Nevertheless, no definite conclusions can be drawn from this particular study.

Table II summarizes the results of prolonged feeding in the same two normal boys previously mentioned. The first one of these, as can be seen from his height age at the beginning of the study, comes from a family of very short individuals. Consequently, the gain of 3.3 months in height age during 4.6 months of elapsed time can be considered perfectly normal in his case. The most striking aspect of his study is the fall in serum albumin during the first 68 days, when the diet provided 8% protein calories, the stabilization during the next 64 days when it provided approximately 10% protein calories, and the further fall during the last 7 days when the diet provided only 8% protein calories.

The second boy, #190 was of normal height at the beginning of the study but was obviously overweight. During 144 days on Mx-37 (4.7 months) he gained 8.5 months in height age, despite a loss of 4.0 months in weight age. Serum albumin, though falling slightly, was still in the high normal range.

Discussion

The limited number of studies with this product gave such consistently good results that one can confidently state that the soy-whey mixture is an excellent source of dietary protein. Despite moderately inferior nitrogen absorption, probably attributable to the soy flour, the retentions were the equal of those from casein. In all of the studies there was a consistent tendency for serum albumin to fall off slightly

during the Mx-37 dietary periods. This is consistent enough to be significant, although in most cases the serum albumin still remained in the normal range. We suspect that this tendency is probably due to the fact that the mixture undoubtedly has methionine as its first-limiting amino acid. Our experience over the years with products limiting in methionine has been consistently similar to that observed here in the serum albumin values. If it provides at least 8% of calories as protein, this product can confidently be recommended as the only source of protein in the diet of infants and children. The one child, #190, who was the oldest in the study, did show some loose stools probably attributable to the high lactose content of the mixture. A lactose tolerance test on two different occasions was indicative of low intestinal lactase activity which is the rule, rather than the exception, in Peruvian Mestizo children of his age. The possibility of encountering diarrhea in preschool children given mixtures with a high content of sweet whey must be kept in mind.

Table I

Comparisons between Casein (C) and a soy-whey mixture (Mx-37) as the only source of protein in the diet of convalescent malnourished and normal infants.

| D a i l y P r o t e i n S o u r c e | D i e t | | N i t r o g e n B a l a n c e s | | | | | | Δ Wt g/kg /day | S e r . A l b u m i n | |
|--|-------------|--------------|-----------------------------------|-----------|------|-----------|------|----------------------|-----------------------------|-------------------------|------|
| | Kcal /kg | # of days | on days | mg/kg/day | | % of Int. | | g/100 ml Δ | | Final | |
| g/kg | | | | int. | ret. | abs. | ret. | | | | |
| #196M - age 22.6 mos., ht. 76.5 cm., wt. 9.23 kg. | | | | | | | | | | | |
| C | 2.0 | 100 | 9 | 4-9 | 320 | 76 | 85 | 24 | 3.2 | 0.39 | 4.82 |
| -37 | 2.0 | 100 | 30 | 1-3 | 320 | 2 | 71 | 1 | | | |
| | | | | 4-5 | 320 | 71 | 77 | 23 | | | |
| | | | | 25-30 | 320 | 97 | 71 | 30 | 2.5 | -0.49 | 4.33 |
| C | 2.0 | 100 | 9 | 1-9 | 320 | 48 | 78 | 15 | 1.9 | 0.16 | 4.49 |
| #198M - age 10.4 mos., ht. 64.1 cm., wt. 5.37 kg. | | | | | | | | | | | |
| C | 2.0 | 150 | 10 | 5-10 | 320 | 84 | 80 | 26 | 8.6 | -- | 4.10 |
| -37 | 2.0 | 150 | 14 | 1-9 | 320 | 78 | 77 | 25 | 5.9 | -0.33 | 3.77 |
| -37 | 2.0 | 125 | 23 | 18-23 | 320 | 117 | 76 | 37 | 5.3 | 0.58 | 4.35 |
| C | 2.0 | 125 | 9 | 1-9 | 320 | 80 | 81 | 25 | 1.4 | -0.73 | 3.62 |
| #202M - age 7 mos., ht. 58.4 cm., wt. 5.12 kg. | | | | | | | | | | | |
| C | 2.0 | 125 | 13 | 8-13 | 320 | 120 | 88 | 38 | 5.2 | 0.18 | 4.17 |
| -37 | 2.0 | 125 | 30 | 1-9 | 320 | 92 | 83 | 29 | | | |
| | | | | 25-30 | 320 | 122 | 79 | 39 | 4.4 | -0.23 | 3.94 |
| C | 2.0 | 125 | 9 | 1-9 | 320 | 106 | 85 | 33 | 5.9 | 0.17 | 4.11 |
| #199M - age 14.8 mos., ht. 71 cm., wt. 9.4 kg. | | | | | | | | | | | |
| -37 | 2.0 | 100 | 8 | 3-8 | 319 | 73 | 78 | 23 | 3.6 | -0.52 | 3.25 |
| C | 2.0 | 100 | 7 | 1-7 | 310 | 72 | 84 | 23 | 2.3 | 0.48 | 3.73 |
| #190M - age 27.3 mos., ht. 88.3 cm., wt. 14.25 kg. | | | | | | | | | | | |
| -37 | 2.5 | 100 | 14 | 4-9 | 374 | 163 | 83 | 44 | 0.4 | -0.10 | 4.61 |
| -37 | 2.0 | 100 | 8 | 2-7 | 320 | 44 | 70 | 14 | -3.1 | -0.23 | 4.01 |
| C | 2.0 | 100 | 7 | 3-7 | 320 | 89 | 82 | 28 | 6.0 | -0.18 | 3.83 |

Table II

Prolonged feeding of soy-whey mixture (Mx-37) as the only source of protein in the diet of two normal boys. Evolution in chronologic age (CA), height age (HA) and weight age (WA), and in serum albumin.

| Case # | Initial Ages in months | | | Daily Diet | | | Progress in months | | | Ser. Albumin g/100 ml | |
|--------|------------------------|------|------|------------|----------|-----------|--------------------|-----|------|-----------------------|-------|
| | CA | HA | WA | Prot. g/kg | Kcal /kg | # of days | CA | HA | WA | Δ | Final |
| 199 | 10.3 | 6.0 | 8.5 | 2.5 | 125 | 68 | | | | -0.40 | 3.86 |
| | | | | 3.0 | 125 | 51 | | | | -0.06 | 3.80 |
| | | | | 2.5 | 100 | 13 | | | | -0.03 | 3.77 |
| | | | | 2.0 | 100 | 7 | 4.6 | 3.3 | 2.3 | -0.52 | 3.25 |
| 190 | 27.3 | 25.0 | 36.0 | 2.5 | 100 | 136 | | | | -0.47 | 4.24 |
| | | | | 2.0 | 100 | 8 | 4.7 | 8.5 | -4.0 | -0.23 | 4.01 |