AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

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1. SUBJECT CLASSIFICATION

A. PRIMARY: Public Health

B. SECONDARY: Nutrition

2. TITLE AND SUBTITLE

Critical evaluation of new protein sources for the prevention of malnutrition, substantive progress report on cottonseed flours: Part II

3. AUTHOR(S)

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4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1967	10 p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

British-American Hospital, Department of Research, Lima, Peru

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

Results with glandless cottonseed flour were somewhat paradoxical. Compared to modified cow's milk, the absorption and retention of nitrogen were distinctly superior to what would have been expected with "degossypolized" cottonseed flour. Rates of weight gain also were superior and the levels of serum albumin attained were quite comparable to those from "degossypolized" cottonseed flour in other subjects. In these studies, as well as in the initial treatment of malnourished infants, there was a more pronounced tendency for sodium to be retained and a distinctly greater tendency to develop pellagra-like manifestations. Although the latter is suspected of being related to the unavailability of tryptophan, inadequate for pyridine nucleotide synthesis, this cannot be proved at this time. Based on these studies, however, it is believed that as part of a mixture containing natural foods, this cottonseed flour would prove superior to those from ordinary cottonseed meal which has been "degossypolized" by physical or chemical methods.

10. CONTROL NUMBER

PN-AAC-580

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Cottonseed
Proteins

13. PROJECT NUMBER

14. CONTRACT NUMBER

CSD-1433 Res.

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

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SUBJECT: Substantive Progress Report
January 1, 1967 - June 30, 1967
AID/csd-1433, Critical Evaluation of New Protein Sources for the Prevention of Malnutrition.

INTRODUCTION

The results reported here are those obtained in the evaluation of a number of cottonseed flours. The work dealing with the evaluation of CF-21, CF-22, and CF-332 was carried out prior to the initiation of this research contract, having been supported by a grant from UNICEF and grants AM-04635, AM-09137 and AM-09980 from the National Institutes of Health, U. S. Public Health Service. The evaluation of CF-27 and CF-26 was carried out during the time covered by this report. In order to make this a more useful document it was decided to combine these results into a single report in two parts, one covering "degossypolized" cottonseed flours, and the other covering glandless cottonseed flour. During the same six month period work has been continued on other products and begun on a number of new ones. The results of these studies will be reported at a later date.

PART II.

GLANDLESS COTTONSEED FLOUR

Comparative and Long-Term Studies

In Table 1 are summarized our experiences with glandless cottonseed flour in the diet of convalescent malnourished infants. In these studies comparisons with modified cow's milk or casein were followed by long-term feeding of the same protein. The first two cases were complicated by the same error in the vitamin mixture reported in Part I.. In the last three cases, despite our use of the standard vitamin preparation, deficiency manifestations were also encountered in one or possibly two of the three.

In all five cases the absorption of nitrogen from CF-26 was as good or better than that from modified cow's milk. The retention of nitrogen in all five cases was also very comparable to that from modified cow's milk. In four of the five, however, the rates of weight gain were lower than on equivalent milk intakes. Although the levels of serum albumin attained in all five cases were slightly inferior to those attained on modified cow's milk, they were generally maintained above 4.0 gm/100 ml. After prolonged feeding, however, in three of the five cases, the serum albumin fell to approximately 3.5 gm/100 ml.

In Case #120M, after 119 days on CF-26 as the sole source of protein at marginal levels of intake, the rate of weight gain had fallen appreciably and the serum albumin had fallen to 3.55 gm/100 ml. This case was complicated by an inadequate vitamin intake but even when this was corrected the rate of weight gain did not recover and there was definite anorexia and some vomiting. A change to modified cow's milk resulted in prompt recovery of serum albumin and a rapid rate of weight gain.

In Case #123M a pellagroid dermatitis and diarrhea developed. These did not respond to supplementary tryptophan, niacin and pyridoxine and only disappeared when the source of dietary protein was changed to casein. Relapse occurred, however, on the casein diet and a change to modified cow's milk was eventually necessary, suggesting that a deficiency state had developed which could not be corrected without a change to a natural food.

In Case #125M, the occurrence of infection was followed by the appearance of

pellagroid dermatitis and diarrhea. Improvement of the infection and decreasing the caloric intake were probably more important than tryptophan supplementation in clearing these manifestations. An increase in the caloric intake was associated with a relapse in the dermatitis, which improved but did not disappear when the protein intake was raised.

In Case #130M the absorption and retention of nitrogen as well as the rate of weight gain on CF-26 were very similar to those on modified cow's milk. There was, however, a distinct fall in serum albumin to 3.57 gm/100 ml after 46 days.

In Case #135M, when CF-26 was given as 6.4% of calories, the pellagroid dermatitis appeared. Despite a lowering of the caloric intake to the point where weight gain practically ceased, the dermatitis persisted and diarrhea developed. Further curtailment of caloric intake, resulting in weight loss was associated with disappearance of the dermatitis and diarrhea.

In malnourished infants pretreated with modified cow's milk the absorption and retention of nitrogen, the rate of body weight gain, and the levels of serum albumin maintained were probably superior to those attained with "degossypolized" cottonseed flour and previously reported. On the other hand, manifestations which may well be due to tryptophan deficiency appeared much more readily when this cottonseed flour was the only source of dietary protein.

Initial Dietary Treatment

On the basis of the previous results it was felt justified to use this protein source in the initial dietary treatment of severely malnourished infants. Table 2 summarizes the results in two marasmic infants. It must be noted that both of these were younger than the marasmic infants who received degossypolized cottonseed flour in their initial treatment.

Despite an initial serum albumin of 2.46 gm/100 ml this infant did not have other manifestations of kwashiorkor and is therefore calssified as "simple" marasmus. During the course of 22 days his protein intake from CF-26 was gradually increased to 4.0 gm/kg/day while his claoric intake was increased to 125 Calories/kg/day. Despite deceivingly good rares of weight gain, the nitrogen retention on the days on which it was measured was very poor and the serum albumin fell to 1.88 gm/100 ml, with clinical edema becoming evident. Because of this unfavorable turn of events

he was changed to a mixture of modified cow's milk and casein for 8 days, he lost his edema and the serum albumin began to rise. On modified cow's milk he then continued to make a satisfactory recovery. On the basis of experience with other similar infants, it is probable that if we had withheld sodium from the diet during the initial treatment he might have made a good recovery on this source of protein. As is, he must be counted as a failure.

In Case #134M, when an intake of 3.0 gms of protein/kg/day was reached, satisfactory retentions of nitrogen were demonstrated and a good rate of weight gain maintained, excepting a short period during which infection was evident. During this time the serum albumin hovered around 3.5 gm/100 ml. When the caloric intake was raised to 150 Calories/kg/day some edema may have been transitorily present. When the caloric intake was further raised to 175, nitrogen retention was excellent, the rate of weight gain very brisk and serum albumin rose to 3.90 gm/100 ml, but he developed diarrhea and a pellagroid dermatitis. Lowering the caloric intake resulted in clearing of the manifestations and it was possible to continue the product for an additional 136 days with moderate but steady weight gain.

In the initial treatment of two infants with marasmic kwashiorkor, summarized in Table 3, the results were generally satisfactory but in both cases pellagroid dermatitis, and in one of them, sodium retention, was a problem.

In Case #130M satisfactory retention of nitrogen was only demonstrated when the caloric intake was 150 Calories/kg/day. In this patient the initial use, by error, of an inadequate vitamin mixture probably contributed to the development of pellagroid dermatitis and diarrhea at a time when nitrogen retention, weight gain, and evolution of serum albumin were satisfactory. Although there was an apparent initial response to tryptophan supplementation, an intercurrent infection resulted in frank relapse and the need to change to a modified cow's milk formula.

In Case #133M, despite very satisfactory retention of nitrogen, edema increased and serum albumin levels remained low. On a sodium-free diet there was continued satisfactory nitrogen retention, a good diuresis and a prompt rise in serum albumin. Subsequently, an intercurrent infection precipitated the development of pellagroid dermatitis and the source of dietary protein was changed to modified cow's milk.

Prior to this change, it had been demonstrated that the severe fatty infiltration of the liver which was present on admission had disappeared completely.

Our results with glandless cottonseed flour are somewhat paradoxical. On the basis of comparisons with modified cow's milk, the absorption and retention of nitrogen were distinctly superior to what we would have expected with "degossypolized" cottonseed flour. Rates of weight gain were also superior and the levels of serum albumin attained were quite comparable to those from "degossypolized" cottonseed flour in other subjects. In these studies, as well as in the initial treatment of malnourished infants there was a more pronounced tendency for sodium to be retained and a distinctly greater tendency to develop pellagra-like manifestations. Although we suspect that the latter are related to unavailability of tryptophan, inadequate for pyridine nucleotide synthesis, we cannot prove this supposition at this time. On the basis of these studies, however, we believe that as part of a mixture containing natural foods, this cottonseed flour would prove superior to those from ordinary cottonseed meal which has been "degossypolized" by physical or chemical methods.

TABLE 1

EVALUATION OF GLANDLESS COTTONSEED FLOUR(CF26) IN THE DIET OF CONVALESCENT MALNOURISHED INFANTS. COMPARISONS WITH MODIFIED COW'S MILK (M) AND CASEIN (C). DIET PERIODS ARE CONSECUTIVE.

DIET				NITROGEN BALANCES				△ WT	Ser.ALBUMIN g/100ml		
Protein & g/kg/day	Cal/kg/day & % prot'n		No. days	Balances on days:	Ab. %	Reten'n %	mg/kg	g/kg /day	△	final	
#120M - 21 months - 72.9cm(normal for 11 mo.)- 8.31kg(normal for 8 mo.)											
M	2.0	125	6.4	41	36-41	81	29	87	3.0	0.45	4.86	1,2
CF26	"	"	"	14	2-13	82	36	112	1.9	-0.11	4.75	
"	"	"	"	42	-	-	-	-	0.8	-0.13	4.62	3
"	"	"	"	63	-	-	-	-	0.2	-1.07	3.55	1,2,4
M	"	"	"	5	-	-	-	-	3.7	0.50	4.05	
#123M - 4 months - 60.9cm(normal for 3 mo.)- 4.80 kg (normal for 2 mo.)											
M	2.5	150	6.7	6	1-6	68	30	121	8.6	-0.89	4.06	
CF26	"	"	"	40	1-9	73	23	94	5.0	0.06	4.12	3,5
"	"	"	"	38	29-34	67	25	89	3.9	0.24	4.36	5,6
"	"	100	10.0	29	26-29	73	19	76	1.3	-0.21	4.15	4,5,6,7,8
C	2.0	75	10.7	3	1-3	83	44	142	-1.4	-	4.15	10
"	2.5	100	10.0	17	-	-	-	-	2.5	-0.05	4.10	11
#125M- 7 months - 56 cm(normal for 1 mo.)- 4.58 kg (normal for 1 mo.)											
M	3.0	150	8.0	13	8-13	86	37	180	9.2	0.21	4.32	
CF26	"	"	"	21	1-2,13-18	82	32	152	8.8	-0.49	3.83	
"	"	"	"	15	-	-	-	-	1.4	0.11	3.94	9
"	2.5	"	6.7	59	-	-	-	-	3.4	-0.14	3.80	5,8,9
"	"	125	8.0	9	-	-	-	-	5.7	0.34	4.14	5,6
"	"	75	13.3	45	-	-	-	-	0.1	-0.33	3.81	11
"	"	100	10.0	14	-	-	-	-	4.0	-0.16	3.65	
"	"	125	8.0	23	-	-	-	-	4.1	0.27	3.92	5
"	4.0	"	12.8	7	5-7	86	34	188	-3.8	-0.27	3.65	2,9,10
M&C	"	"	"	9	1-3	93	47	262	8.4	-0.01	3.64	11
#130M - 26 months - 73 cm(normal for 11 mo.)- 8.38kg(normal for 8 mo.)											
M	2.0	100	8.0	49	44-49	74	17	54	2.2	-0.52	4.28	
CF26	"	"	"	46	1-9	86	28	90				
					38-46	75	22	70	2.8	-0.71	3.57	
M	"	"	"	16	1-6	79	21	68	2.9	0.73	4.30	
#135M - 32 months - 78.8cm(normal for 15 mo.)- 9.80kg(normal for 11 mo.)											
M	2.0	125	6.4	16	4-16	60	24	77	4.8	-0.09	4.08	
CF26	"	"	"	22	1-9	78	31	101	3.5	-0.02	4.06	5
"	"	100	8.0	19	-	-	-	-	0.3	0.13	4.19	5,8
"	"	75	10.7	15	12-15	76	23	72	-2.2	0.15	4.34	11
M	"	"	"	4	1-4	70	15	49	-3.6	-0.25	4.11	8
C	"	"	"	10	1-6	86	21	69	-1.8	-	4.1	

1=anorexia, 2=vomiting, 3=inadequate vitamin mix, 4=normal liver on biopsy, 5=pellagroid dermatitis, 6=tryptophan supplement, 7=niacin & pyridoxine supplem., 8=diarrhea, 9=infection, 10=dermatitis improved, 11=dermatitis cleared.

TABLE 2

GLANDLESS COTTONSEED FLOUR (CF26) IN THE INITIAL DIET THERAPY OF MARASMIC INFANTS.

DIET					NITROGEN BALANCES				△ WT	Ser.ALBUMIN g/100ml		Notes
Protein & g/kg/day		Cal/kg/day & %	prot'n	No. days	Balances on days:	Ab. %	Reten'n %	mg/kg	g/kg /day	△	final	
#125M - 4 months - 51.2cm(normal for newborn)- 2.46kg(normal for newborn)												
CF26	2.0	75	10.7	4	-	-	-	-	15.6	-0.19	2.27	
"	2.5	110	9.1	5	4-5	62	5	21	4.1	0.01	2.28	
"	3.0	125	9.6	7	-	-	-	-	6.6	-0.12	2.16	1
"	4.0	"	12.8	6	-	-	-	-	5.9	-0.28	1.88	1
M&C	variable			8	-	-	-	-	-17.0	0.70	2.58	
M	3.0	142	8.4	19	-	-	-	-	9.0	1.42	4.00	
"	"	175	6.9	46	15-23	80	45	217	9.5	0.22	4.22	2
"	variable			6	-	-	-	-	-6.0	-0.11	4.11	3
"	3.0	150	8.0	13	8-13	86	37	180	9.2	0.21	4.32	
#134M - 9 months - 62.5 cm (normal for 4 mo.)- 4.65 kg (normal for 1 mo.)												
CF26	2.0	75	10.7	3	-	-	-	-	10.0	-0.15	3.16	
"	2.5	100	10.0	3	-	-	-	-	4.2	0.73	3.89	4
"	3.0	"	12.0	4	1-3	81	40	194	6.6	-0.81	3.08	5
"	"	125	9.6	5	3-5	74	14	67	-0.8	0.38	3.46	5
"	"	150	8.0	17	1-6	78	30	146	5.4	-0.04	3.42	1 (?)
"	"	175	6.9	32	16-21	81	36	175	10.4	0.48	3.90	5,6,3
"	"	125	9.6	45	5-10	86	36	177	1.1	-0.22	3.68	7
"	2.5	"	8.0	35	-	-	-	-	1.1	0.26	3.94	
"	2.0	"	6.4	56	-	-	-	-	0.8	0.07	4.01	
"	"	75	10.7	9	2-9	82	33	105	-0.2	-0.19	3.82	
M	"	"	"	6	1-6	86	24	77	-2.7	0.34	4.16	

Footnotes:
1= edema
2= liver normal on biopsy
3= diarrhea
4= very little fat on liver biopsy
5= infection
6= pellagroid dermatitis
7= dermatitis and diarrhea cleared

TABLE 3

GLANDLESS COTTONSEED FLOUR (CF26) IN THE INITIAL DIET THERAPY OF INFANTS WITH MARASMIC KWASHIORKOR.

DIET					NITROGEN BALANCES				△ WT	Ser.ALBUMIN		
Protein & g/kg/day	Cal/kg/day & %	prot'n	No. days	Balances on days:	Ab. %	Reten'n %	mg/kg	g/kg /day	△	g/100ml final	Notes
#130M - 22 months - 70.5cm(normal for 8 mo.)- 6.11kg(normal for 4 mo.)											
CF26	2.0	75	10.7	4	-	-	-	-	10.0	-0.12	2.28	
"	2.5	100	10.0	21	3-4	71	18	73	0.6	0.94	3.22	1
"	"	125	8.0	7	-	-	-	-	5.0	0.71	3.93	2
"	"	150	6.7	6	-	-	-	-	5.5	-0.85	3.08	2,3,4,5
"	"	"	"	10	5-10	76	36	146	8.3	0.59	3.67	6,7
"	"	"	"	27	21-26	82	45	175	5.6	-0.08	3.59	3,4,5,8,9
"	variable			16	-	-	-	-	0.8	0.38	3.97	3,4,5
M	variable			33	-	-	-	-	-1.6	0.83	4.80	10
M	2.0	100	8.0	49	44-49	74	17	54	2.2	-0.52	4.28	
#133M - 8 months - 59.0cm(normal for 2 mo.)- 3.44kg(normal for newborn)												
CF26	2.0	75	10.7	5	-	-	-	-	2.2	-0.52	2.50	11
"	3.0	100	12.0	9	4-9	77	30	145	15.8	0.11	2.61	12
"	"	125	9.6	16	1-6	83	28	137	-0.9	0.97	3.58	13,14
"	"	150	8.0	10	5-10	83	33	158	7.3	0.06	3.64	13,15
"	"	"	"	32	1-9	78	28	136	7.4	0.14	3.78	3.4,9
M	variable			22	-	-	-	-	0.4	0.88	4.66	10,16
M	2.5	125	8.0	12	7-12	87	28	113	8.2	-0.02	4.64	

Footnotes:
1= 2+ fat on liver biopsy
2= inadequate vitamin mix
3= infection
4= pellagroid dermatitis
5= diarrhea
6= tryptophan supplement
7= dermatitis cleared
8= edema
9= liver normal on biopsy
10= cleared as infection cleared
11= 4+ fat on liver biopsy
12= edema increased
13= sodium-free diet
14= edema decreased
15= edema cleared
16= some diarrhea and vomiting

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