THE SUPPLEMENTARY NUTRITIVE VALUE OF COCONUT CAKE (*COCOS NUCIFERA*)

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During the period preceding World War II, the western part of the Madras Presidency in India was mainly dependent on Burma for its supplies of rice to supplement what was available on that Coast. With the occupation of Burma and the neighbouring countries by the Japanese, these supplies were completely cut off with the result that tapioca (*Manihot utilissima*) came into much greater use as food than at any time before. With the present continued shortage of food grains, this article of food still continues to be the staple food of majority of the people in these areas.

Karunakaran[1] in his report to the Technical Commission on Nutrition of the League of Nations, stated that tapioca had come into greater use as a staple food in the couple of decades preceding the date of his report and that this was due to pressure of population on land. He estimated that if tapioca were the staple food, the energy requirements of an adult man per year could be met from 0·2 to 0·4 of an acre of land whereas 0·76 to 1·45 acre respectively would be required if potatoes or wheat were the staple food. The average yield of tapioca per acre is about two to 5 tons. He added that " tapioca has undoubtedly helped the people to escape famine and the privations which have affected other parts of India, but it has at the same time accounted for the progressive deterioration in the physique and an increased incidence of disease of various kinds". In 1943–44, the production of tapioca increased by about 33 per cent. and was placed at about 750,000 tons. In the Cochin State, and the districts of Malabar, the area was almost doubled (Sreeramamurthy[2]). Thus, tapioca is a food crop of growing importance.

Krishnan[3] observed that children living in a tapioca-producing area were smaller and lighter in build at all ages than rice-eating children in other parts of India. It has been estimated that about 75 per cent. of the population of Travancore was consuming tapioca in various forms. No data are available for other parts of the West Coast. Aykroyd and Krishnan[4] in studying the supplementary nutritive value of various protein-rich foods when added to a tapioca diet, observed that dried yeast, pulses or soyabean did not improve the growth rate of rats to any appreciable extent but that casein at a 6 per cent. level of intake brought about an average weekly growth rate of 5·9 grams. They concluded that the defect of a tapioca diet may

be due to the quantity and probably also the quality of the protein in it. The low protein content of tapioca is well known; animals on a tapioca diet alone soon lost weight and died during the period of experiment. Sreeramamurthy[2] studied in detail the nutritive value of tapioca and the quality of protein in it. He came to the conclusion that the protein contains a fair distribution of the essential amino acids and that therefore, the defect is due only to the low protein content. Therefore, then, a supplement of a protein-rich material should correct the defects of the tapioca diet. Swaminathan[5] reported a biological value of 77 for coconut proteins and observed that in general, the proteins of nuts, and oilseeds are superior to those of pulses. John, Finks and Gersdorff[6] observed in their feeding experiments that coconut proteins supplied most of the important amino acids. Sherman[7] placed coconut protein on an almost equal footing with the proteins of egg, meat, fish, etc., and recommended its use as a supplement to the cereal diet in view of the relatively low lysine content of grain proteins and the higher lysine content of coconut proteins.

Animal experiments were, therefore, carried out to assess the value of coconut cake (defatted coconut meal) as a supplement to the "poor rice" diet and the tapioca diet.

Experimental

Rats weighing about 50 grams and 4 to 5 weeks old were divided into groups of 6 each with an equal distribution between the sexes in the groups. The poor rice diet used in these experiments had the following composition (Aykroyd, Krishnan, Passmore and Sundararajan[8]):—

	Grams
Rice, raw	596
Dhal Arhar (*Cajanus indicus*) ..	20
Black gram (*Phaseolus mungo*) ..	20
Brinjals (*Solanum melongena*) ..	28
Amaranth leaves (*Amaranthus gangeticus*)	14
Raw plantain (*Musa paradisciaca*) ..	14
Gingelly oil (*Sesamum indicum*) ..	3
Coconut, fresh (*Cocos nucifera*) ..	1·4
Meat (Mutton)	1·7

This diet supplied about 45 to 47 grams protein working to about 6·7 per cent. This diet has been worked out as a result of diet surveys made among the poorer classes of South India and used extensively on work of similar nature in the Nutrition Research Laboratories, Coonoor. While the first group of rats was fed the poor rice diet, the second, third and fourth groups

received 10, 20 and 30 per cent. respectively of coconut cake in the place of an equal quantity of rice. The rats were fed the cooked diet *ad libitum* and the experiment was run for a period of eight weeks. The animals were weighed every week and the results are shown in Table I and graphically

TABLE I

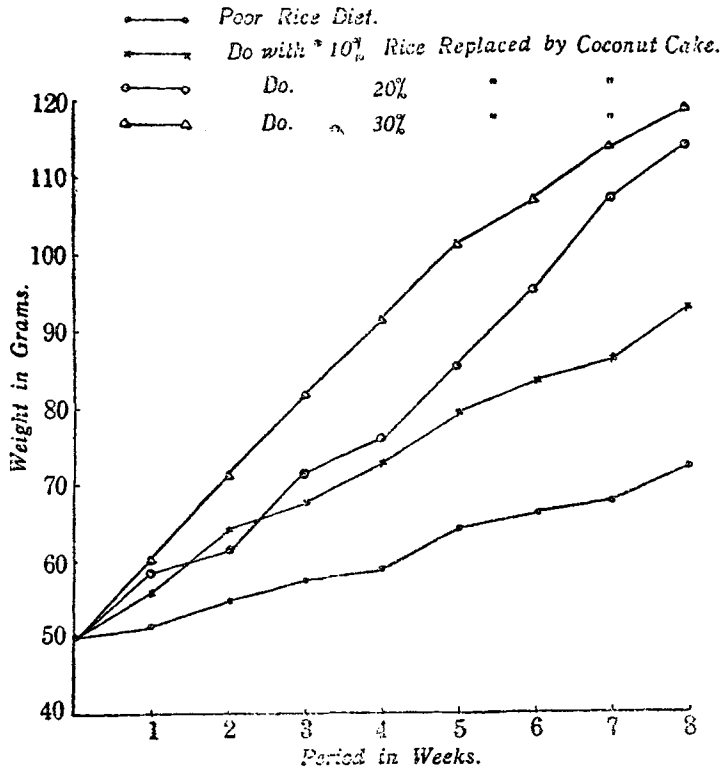
Value of coconut cake as a supplement to poor rice diet

Diet	Protein in diet %	Initial weight of rats gm.	Final weight of rats gm.	Average weekly increase in weight of rats gm.
1. Poor rice diet ..	6·7	49·5	72·0	2·8 ± 0·14
2. Do. with 10 per cent. of rice in diet replaced by coconut cake ..	8·26	49·5	93·0	5·4 ± 0·98
3. Do. with 20 per cent. of rice in diet replaced by coconut cake ..	9·66	49·5	113·5	8·0 ± 0·84
4. Do. with 30 per cent. of rice in diet replaced by cocoanut cake ..	11·14	49·5	118·5	8·6 ± 0·70

in Fig. 1. It will be seen from these results that coconut cake added to a poor rice diet has a beneficial effect on growth rate of rats at all the levels investigated.

For the experiments on the value of coconut as a supplement to the tapioca diet, the basal diet was modified in certain respects so as to correspond to the conditions prevailing on the West Coast of the Madras Presidency at the present time. Thus, rice in the poor rice diet was replaced by dried, powdered tapioca and pulses were omitted for the reason that during the present food shortage, they were not available in even inadequate quantities and that when available, they were far too costly for the poorer classes to afford them. Though this applies to meat and fish also, meat was included in the experimental diets to correspond to what little of it they may consume occasionally. Thus, the diet, as used in these investigations, had the following composition:

	Grams
Tapioca (dried)	91·0
Brinjal	4·0
Amaranth leaves	2·0
Plantain, raw	2·0
Meat, (Mutton)	0·5
Coconut oil	0·5



TEXT-FIG. 1. The supplementary effect of coconut cake on a 'poor rice' diet.

The experimental details were the same as described earlier, but the second and third groups received coconut cake at 30 per cent. level in the place of an equivalent amount of tapioca. The rats of the third group received a supplement of calcium in the form of calcium carbonate during the first four weeks of experiment and thereafter, an equivalent of calcium lactate (0·4 gram Ca per cent.). The calcium supplement was made because it was found by analysis that the calcium content of the diet itself and after substitution with 30 per cent. coconut cake was low and not in proportion to the phosphorus content. This was especially so in the supplemented diet of the second group. The protein, calcium and phosphorus contents of the diets are shown in Table II.

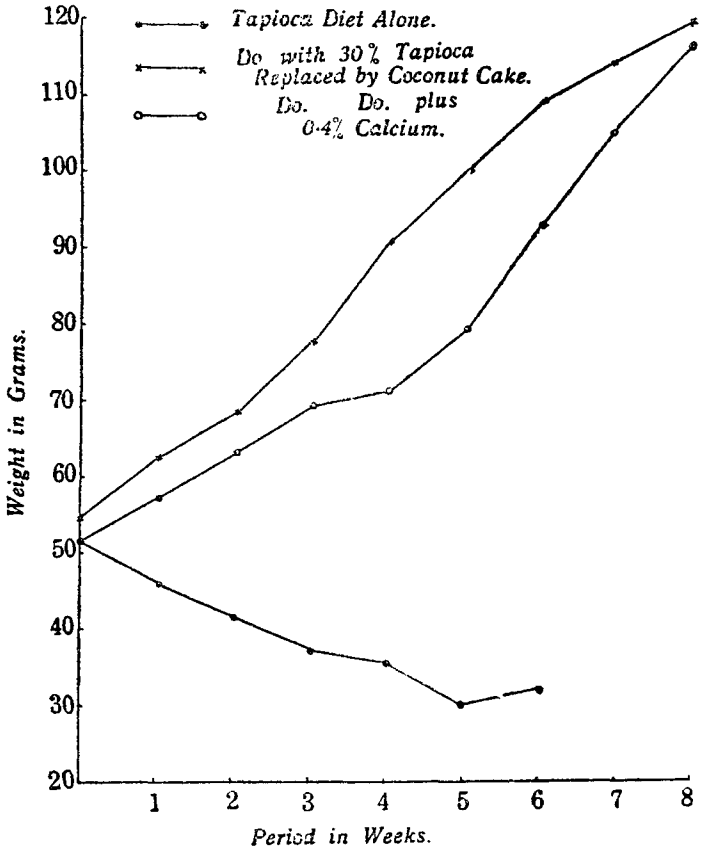
During the first four weeks of the experiment, when calcium carbonate had been added to the third group, it was observed that the rats did not grow as satisfactorily as was to be expected and therefore, from the commencement of the fifth week of the experiment, calcium lactate in equivalent quantity was added in the place of calcium carbonate.

TABLE II

The protein, calcium and phosphorus contents of diets based on tapioca

Diet	Protein %	Calcium %	Phosphorus %	Ca/P
1. Modified tapioca diet ..	2·258	0·064	0·057	1·13
2. Do. with coconut cake at 30 per cent. level ..	9·713	0·078	0·200	0·39
3. Do. with coconut cake at 30 per cent. level *plus* calcium supplement (0·4 per cent.) ..	9·931	0·324	0·179	1·82

Thereafter, growth improved till at the close of the experiment (eighth week) the average final body weight of this group of rats approximated that of Group 2 (Fig. 2).



TEXT-FIG. 2. The supplementary effect of coconut cake on a tapioca diet.

It is to be seen from the figure that rats on tapioca diet alone quickly lost weight and died in about six weeks while the animals in other groups showed an average weekly increase in weight of about 8 grams.

It was mentioned earlier in this paper that children living in tapioca-producing areas were smaller and lighter in body build at all ages than rice-eating children in other parts of India (Krishnan).[3] It would therefore be of interest to find out if coconut supplements with and without extra calcium will help in increasing the weight of bones in rats. Therefore, at the close of the experiment (in Group 1 when the rats died), the femurs of the rats were collected, fat extracted with ether-alcohol mixture and dried to constant weight. The ash content, calcium and phosphorus in the bones were also determined. The results are presented in Table III, from which it will be

TABLE III

Value of coconut cake as a supplement to a tapioca diet

Diet	Average initial weight of rats	Average final weight of rats	Average weekly increase in weight of rats	Average dry weight of femurs	Ash content of bones	Total calcium (Ca)	Total phosphorus (P)	Ca/P
	gm.	g m.	gm.	gm.	%	mg.	mg.	
1 Modified tapioca diet	52·0	32·0*	−3·3 ±0·35	0·0872 ±0·017	31·21 ±2·41	14·90 ±5·10	6·68 ±1·68	2·23
2 do. with 30 per cent. of tapioca replaced by coconut cake	54·5	119·0	8·06 ±0·70	0·3545 ±0·012	36·82 ±0·40	49·3 ±1·20	25·2 ±1·49	1·96
3 do. with 30 per cent. of tapioca replaced by coconut cake *plus* calcium (0·4 per cent.)	52·0	115·0	8·0 ±0·89	0·4075 ±0·021	43·99 ±0·53	72·4 ±4·65	31·6 ±1·64	2·29

* All the rats in this group died by the end of the sixth week of experiment.

seen that the percentage of ash in the bones is greater when the coconut supplement is made and more so when calcium is also added to this supplement.

DISCUSSION

The value of coconut cake when combined with the poor rice diet, though not so markedly brought out as in the case of tapioca diet, is clearly seen in that it causes an increased growth rate of about 5·8 grams per week over the control when the cake replaces 30 per cent. of the rice in the diet. The average weekly increase in weight when coconut cake replaces 30 per cent. of the rice or tapioca as the case may be, appears to be almost the same.

As a supplement to the tapioca diet, coconut cake showed a greater response. Thus, while rats could not be maintained on a tapioca diet alone

for more than five or six weeks, coconut cake at 30 per cent. level supplying about 8 grams extra protein per 100 grams of diet, improved the growth rate considerably (about 8 grams per week). Calcium supplements did not increase the growth rate in the present experiments, but probably, if calcium had been given in the form of calcium lactate right from the commencement of the experiment, there might have been an appreciable difference in favour of calcium supplement.

The growth rate in the case of coconut cake supplements compared favourably with that obtained by Aykroyd and Krishnan[4] with casein supplements almost at the same level of protein intake. The same authors[9] stated that even on an excellent stock diet, rats in Coonoor gain only 10·6 grams per week. In comparison with this, the growth rate of rats on tapioca diet supplemented with coconut cake at 30 per cent. level seems satisfactory.

The bones of rats on tapioca diet alone were very poorly developed and calcification was also poor. The percentage of ash in femurs was 31·2 for Group 1 while it was 36·6 and 44·0 for those of Groups 2 and 3 respectively. Though it is evident from the results that calcification was not the optimum in the third group of rats, calcium supplement had an ameliorative effect and this finds further confirmation in the results of analysis of bones for calcium and phosphorus.

Thus coconut by itself, considerably improves the nutritive value of both poor rice and tapioca diets and a further supplement of calcium to the tapioca diet tends to improve the mineralization of the bones.

Summary

Experiments have been carried out with a view to finding out the supplementary nutritive value of coconut cake when added to "poor rice" and tapioca diets. It was observed that a supplement of coconut cake at 30 per cent. level increased the weekly growth rate of rats as well as the weight and ash content of bones. Coconut cake can therefore be used as a supplement to "poor rice" and tapioca diets.

References

1. Karunakaran .. *League of Nations, Technical Commission on Nutrition*, 1939. CH/Com. *Exp. Alim.* 147.
2. Sreeramamurthy .. *Indian J. Med. Research*, 1945, **33**, 229.
3. Krishnan .. *Ibid.*, 1939, **26**, 901.
4. Aykroyd and Krishnan .. *Ibid.*, 1939, **27**, 139.
5. Swaminathan .. *Ibid.*, 1937, **25**, 381.
6. John, Finks and Gersdorff .. *J. Biol. Chem.*, 1919, **37**, 149.
7. Sherman .. *Food Products*, 1933, Macmillan, 3rd Edn.
8. Aykroyd, Krishnan, Passmore and Sundararajan *Indian J. Med. Research*, 1940, Memoir 32.
9. —— and Krishnan .. *Ibid.*, 1936, **23**, 731.