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ponds of, say, 5 cents in area in 10 acre blocks of paddy fields to carry immature fish through the summer from one paddy season to the next so that fish could attain their maximum size and weight. Carp fry alone should be encouraged to grow in the paddy fields by excluding all the predacious fish. If exotic varieties of carp, like *Osphronienus gourami*, are able to thrive in paddy fields, the yield of fish in paddy fields could be greatly increased. An average catch of 50 lb. of fish from an acre will indeed, represent a great addition to the supply of food in the country, particularly so when it is a first class source of animal protein.

Dehydrated Banana Products and Their Food Value

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Introduction According to a recent estimate by the Provincial Marketing Officer, Madras, bananas are grown in the province on an area of nearly 140,000 acres. The estimated annual production of fresh banana fruits is of the order of 1,133,000 tons. Of these, *Poovan* accounts for more than half with an annual production of 741,000 tons. *Monthan, Nendran, Kunnan*, Mauritius, *Rasthali, Pachanadan*, Hill bananas and *Chakerakeli* follow next in order of importance, the first two claiming a production of nearly 90,000 tons each per year.

The pre-war exports outside the producing districts were over 910,000 railway maunds, of which the district of Trichinopoly claimed roughly 529,000 maunds, East Godavari, West Godavari and Madura 100,000 maunds each, and the districts of Salem and South Arcot about 70,000 maunds each. The exports by rail outside the province ranged from 80,000 to 90,000 railway maunds, mainly from the Cauvery area to the Mysore State and from 60,000 to 120,000 railway maunds from the Godavari area to the Nizam's Dominions and North India. In effect, the pre-war exports of 140,000 to 210,000 railway maunds may be taken to represent the annual surplus of fresh banana fruits in the province.

Provided the transportation facilities are improved and the demand for Madras bananas is fostered within and outside the province, there is much scope for extending the banana cultivation particularly in the heavy rainfall tracts of Malabar and on the hills of the Madura District where the crop can be raised under rainfed conditions. Such an extension seems desirable as the yield of bananas per acre surpasses that of the staple food crops, and the fresh ripe banana is recognized to be a very valuable and delicious food.

Restrictions in transportation facilities during the war may hinder the course of development of banana-growing industry in certain producing areas, and consequently, gluts in some producing regions and scarcity in others may become the features during the present emergency period. Dehydration of banana suggests itself as a means to tide over such temporary difficulties. The dehydrated bananas can, moreover, be transported more cheaply and conveniently, and they may also help to alleviate the food scarcity to some extent.

The value of banana flour as a food has long been known in some parts of the province. The preparation of banana meal by sun-drying has, therefore, been practised as a cottage industry in the West Coast and in the districts of Tanjore and Trichinopoly. Realising its importance as an auxiliary food during the present times, the Government of Travancore are levying a customs duty of five per cent on banana flour of all grades and varieties exported from that State and have further restricted the export. The Foodstuffs Directorate, New Delhi, are also interested in finding out a source of supply of dried bananas for the use of the defence forces.

Preparation of banana figs by sun-drying has been attempted previously by the Agricultural Department at Aduthurai, Coimbatore and elsewhere, but the quantity produced was small and the popularity of the product was limited owing to its poor keeping quality. Although sun-drying is a simple operation, bananas dried by this method often produce a product which is dirty and mixed with insect eggs. On the other hand, dehydration, by which the moisture is removed by artificial heat in specially prepared chambers, and where temperature and, if possible, humidity and rate of flow of air can be regulated, renders the product free of dust and insect eggs. Furthermore, the risks of damage by rains, storms or cloudy weather are eliminated and a more uniform and superior quality product is claimed by dehydration.

Methods of preparing fig and flour Experiments on the preparation of banana figs and flour dehydration of a large number of varieties were conducted at the Fruit Research Station, Kodur, during 1942-43. The methods employed are briefly described below.

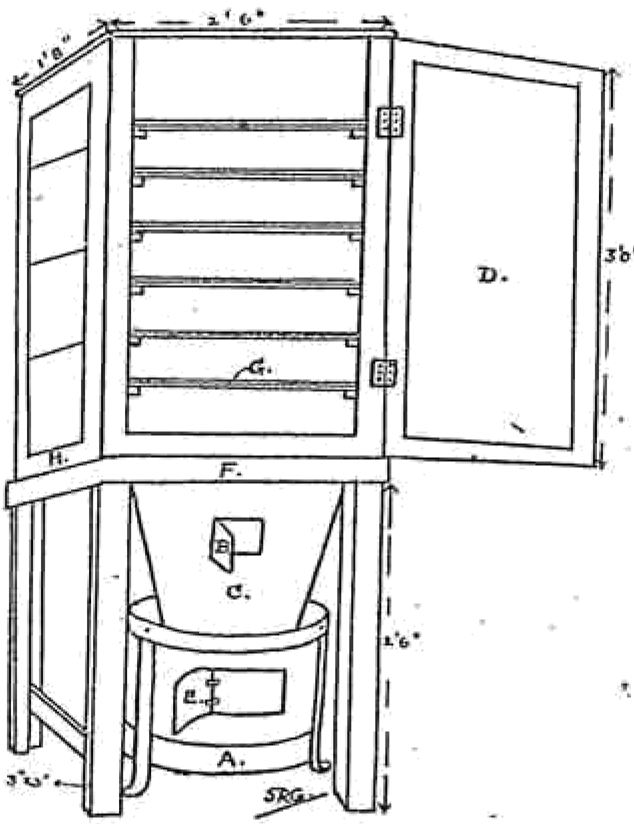
For preparing banana flour, fully matured but slightly unripe bananas were taken and dipped in boiling water for 2 to 3 minutes to facilitate peeling. In some trials, however, ripe fruits were also utilised. After removing the peel by hands, covered with rubber gloves, the pulp was cut into halves or quarters, lengthwise. The slices were then spread on single layers on slat bottom bamboo trays. The trays were then stacked either inside the 'home drier' or in a specially constructed room. The air inside the room or the chamber was heated by means of a charcoal oven or a fire place. By adjusting the ventilators the temperature inside the chamber was maintained at 145°F. to 150°F., while inside the room the temperature ranged from 135°F. to 138°F. When the slices were dry they were removed from the trays, powdered and sifted, and finally stored.

In order to obtain a more attractive and whiter flour, the slices in some of the trials were exposed to the fumes of burning sulphur for 20 minutes before drying.

For the preparation of banana figs the same process as outlined above was adopted except that the slices after dehydration were cut into small pieces and stored as such.

Home drier - its construction and working A small home drier used in these experiments costs about Rs 60 and can easily be constructed by an ordinary village artisan. It is a box (Plate I) 3ft × 1ft. 8in. × 2ft. 6in. resting on a wooden stand 2ft. 6in. high. An iron sheet forms the bottom of the box or chamber. The inside of the door and the portion against which it clings when the chamber is closed are lined with asbestos. The box is provided with two longitudinal openings on the top, each 12 in. long × 1 in. broad for the escape of moisture from inside the box. Another small aperture is provided on the side opposite to the door, to take in a thermometer. The chamber has space for fitting seven trays with bamboo slat bottoms. These trays can be stacked in a staggering manner to allow free circulation of hot air.

PLATE I



The source of heat for the chamber is a charcoal oven which is placed on the ground below the centre of the iron sheet bottom of the chamber. The oven is divided into three sections, the top one for piling up charcoal and for ignition, the central one with a perforated bottom for stoking and for facilitating the removal of ash through the perforated bottom, and the bottom section for collecting the ash. The central section has got two doors or ventilators provided with collapsible shutters. They permit stoking the fire and help to a certain extent to regulate the intensity of the heat.

The oven is fitted up with a chimney which touches the iron sheet bottom of the chamber. This funnel is provided with two windows opposite to each other, and these are with collapsible metallic doors. These help in feeding the oven with charcoal from time to time and also in regulating the heat to some extent. The temperature inside the chamber can be further regulated by opening or closing the door of the chamber.

The chamber maintains a temperature of 145°F. to 150°F. when fully charged. To ensure uniformity in the rate of dehydration, it is necessary to alter the positions of trays by shifting those at the bottom to the top and *vice versa* two or three times in the course of dehydration. The drier has a capacity of dehydrating 30 to 40 lb. of pulp at a time.

Dehydration in a room The dehydration room is constructed of bricks and is 8 ft. long, 7 ft. broad, and 8 ft. 6 in. high at the centre. The roof is made of galvanised iron sheets. The single door is 6 ft. 6 in. × 3 ft. 6 in. and is of ordinary country wood. On each of the two side walls are fitted wooden struts over which the bamboo slat bottomed trays can be stacked in layers with the help of a few bamboo sticks. Opposite the door

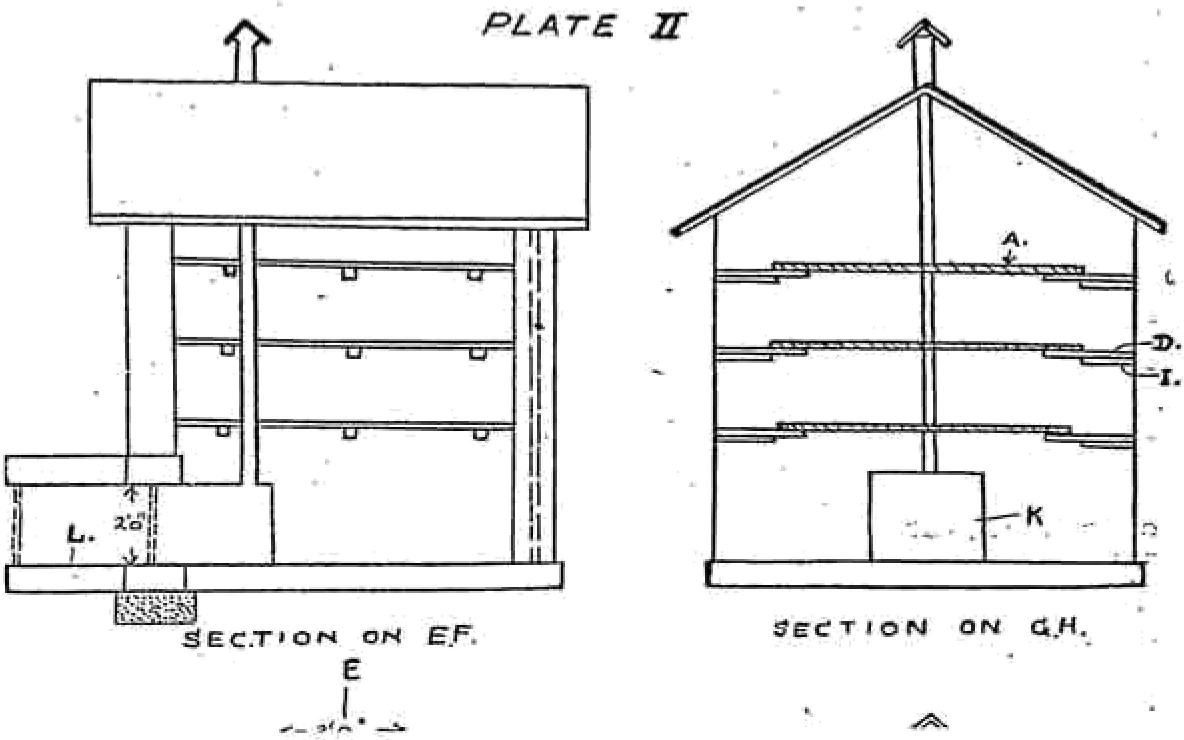
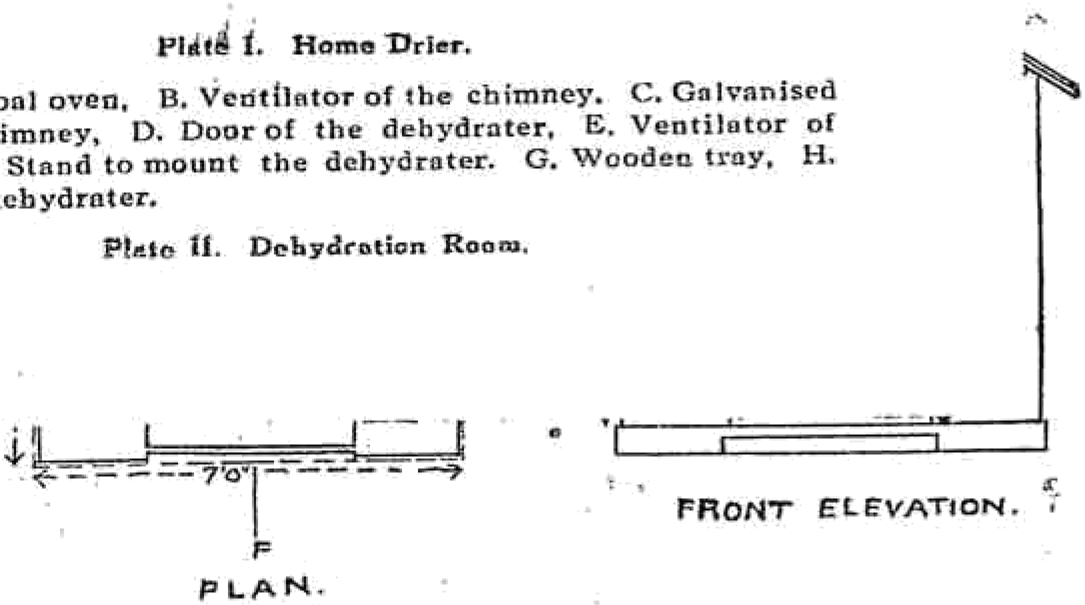


Plate I. Home Drier.

A. Charcoal oven, B. Ventilator of the chimney. C. Galvanised iron or tin chimney, D. Door of the dehydrater, E. Ventilator of the oven, F. Stand to mount the dehydrater. G. Wooden tray, H. Body of the dehydrater.

Plate II. Dehydration Room.



...ill opening to the outside. The fuel consisting of any trash, prunings or dried leaves is ignited through the fire place from outside. The fireplace is closed by a galvanised iron drum from the inside of the room and this serves to radiate the heat. A galvanised iron chimney of

4 in. diameter is built inside the room over the iron drum of the fireplace and rises up above the roof.

When fully charged the room has a temperature range of 135°F. to 138°F. As in the chamber, a slight shifting of the trays is necessary inside the room also to ensure uniformity of dehydration. The room is estimated to cost Rs. 150 to Rs. 200 for construction. It can take about 250 lb. pulp at a time.

Tunnel dehydrater Although the above methods were the only ones used at Kodur, it is possible to dehydrate bananas on a large scale with the help of tunnel dehydraters. These are heated by steam or flue pipes and hot air is forced by means of high velocity fans. The quality of the product dehydrated in this manner is stated to be unsurpassed. The short drying time possible in this is a great advantage. It is reported that in West Indies attempts have also been made to prepare flour from banana pulp by means of drums and vacuum driers. At Kodur, however the 'home drier' and the 'dehydration chamber' have been found to be quite suitable for the purpose.

Results of preparation of Banana figs and flour In all 29 varieties of bananas produced at Coimbatore, Anakapalle, Maruteru, Lower Palni, Tellichery and Kodur were utilised for trials on the preparation of banana figs and flour. The trials were conducted at different periods. It was not possible to adopt a uniform standard of fruit maturity at the commencement of each trial in respect of each variety. Both the 'home drier' and the 'dehydration chamber' do not also lend themselves for regulation of temperature with a high degree of precision. The results obtained, therefore, have to be examined in the above background.

Banana figs Exposing the slices to sulphur fumes for about 20 minutes helps to improve the colour of the final product, rendering it more attractive than the figs prepared from unsulphured fruits. Among the varieties tried the best quality fig was obtained from *Pey Kunnan* variety. *Nendrapadathi* and *Ney Poovan* figs were also good. According to the Processed Food Stuffs Directorate, figs of *Kapur* and *Nendran* were not up to the mark as they absorbed moisture in storage. The percentage of recovery as figs on the basis of fresh fruit weight was highest in *Pey Kunnan*, namely 34·7. In the case of *Ney Poovan* it was 32·0 while in the case of *Nendra Padathi* it was only 20·6.

Ripe fruit does not seem to be well suited for the preparation of figs. In general, the product from such fruits even after sulphuring becomes dark in storage. The flavour of fig from *Pey Kunnan* ripe fruits was definitely poor.

Among the varieties tried, *Bontha Ashy*, *Bontha Green* and *Virupakshi* took the least time for dehydration, possibly owing to their solid flesh and low moisture content. At a temperature of 145° to 150°F. these varieties were completely dehydrated in 9 to 10 hours as against 15 to 22 hours taken by other varieties.

Banana flour In the case of flour also, sulphuring the slices gives a far superior product. Flour from ripe fruit is definitely of a better taste and sweetness than that from unripe fruit. Flour from ripe fruit of *Virupakshi*, *Pey Kunnan* and *Karpura Chakkarakeli* is of a very good quality and is suited for making delicious beverages in no way inferior in flavour to such well-known proprietory products as Ovaltine, etc.

It is, however, much easier to prepare flour from unripe bananas. Such fruits take less period for dehydration and are easily converted into flour after dehydration. Fully mature fruits of certain varieties like *Karpura Chakkarakeli* develop their characteristic ripe peel colour within about an hour of stacking the slices inside the 'dehydration chamber'.

Like the ripe fruits, unripe fruits of *Virupakshi, Bontha Green and Bontha Ashy* could be dehydrated more quickly than other varieties. *Kareem Kadali*, though it dehydrates quickly cannot be as easily peeled by dipping in warm water as the rest of the bananas.

Wide differences were exhibited by varieties in regard to the percentage of recovery as flour. *Nendran*, in spite of its thick peel produced the highest recovery, namely 27·6 and is, therefore, considered to be most economical for flour manufacture. *Pey Kunnan*, with a recovery of 21·2 per cent, *Bontha Ashy* with 21·6 per cent, *Bontha Green* with 20·4 per cent, *Kareem Kadali* with 21·9 per cent and *Ney Poovan* with 22·8 per cent are other suitable varieties from the above point of view. Varieties which gave low recovery of flour are *Karpura Chakkarakeli*, Mauritius and *Pedda pacha arati*, with percentages below 15. The bananas as a whole compare favourably with guavas, in which fruit the recovery of flour was only 12 per cent of the fresh fruit weight.

Banana Figs—Vitamin C values The Director, Nutrition Research, Coonoor, kindly undertook to assay the vitamin C contents of ten samples of figs dehydrated with and without sulphuring. The values are given in Table I.

TABLE I The vitamin C values of banana figs

Serial No.	Variety	Vitamin C—mg. per 100 gm.	
		Sulphured	Non-sulphured
1	*Chinali*	11·25	12·50
2	*Pey Kunnan*	15·00	12·50
3	*Karpur*	12·50	15·00
4	*Kunnan*	13·75	18·75
5	*Nendra Padathi*	18·75	16·25
6	*Ney Poovan*	10·00	7·50
7	*Rasthali*	11·25	15·00
8	*Kali*	11·25	10·00
9	Mauritius	13·75	16·25
10	*Pedda Pacha Arati*	17·50	18·75

It will be observed that the vitamin C content of figs is low. As a source of vitamin C banana figs do not, therefore, seem to be important. The effect of sulphuring seems unimportant. *Nendra Padathi* and *Pedda Pacha Arati* are the two varieties which have shown somewhat higher values of vitamin C than the others.

It may be interesting to compare the above values with those obtained from dehydrated guava flour, data for which are presented below.

TABLE II The vitamin C values of guava flour

Variety	Vitamin C—mg. per 100 gm.
Saharanpur Seedless	310
Allahabad	580
Guava No. 46	490
Smooth Green	280
Red Fleshed	450
Nagpur Seedless	450

Guavas, therefore, are by far a richer source of vitamin C than dehydrated banana figs.

Chemical Analysis *Banana Figs* The chemical analysis of figs from six varieties of unripe bananas was done at Coimbatore by the Government Agricultural Chemist and the results are given in Table III.

TABLE III Showing the chemical analysis of banana figs

Item No.	Head of analysis	*Pey kunnan*	*Nendra padathi*	*Karpura chakkara-keli*	*Kunnan*	*Ney poovan*	*Then kunnan*
1	Moisture	9·19	9·40	9·63	10·69	7·89	8·94
2	Ash	2·58	3·20	3·03	2·29	2·26	2·18
3	Crude proteins	2·89	3·88	3·68	3·00	2·75	3·22
4	Reducing sugars	49·89	44·20	59·12	52·71	48·12	24·47
5	Non-reducing sugars	4·54	7·12	2·14	4·56	3·01	15·20
6	Carbohydrates, fat, fibre etc. (by difference)	30·91	32·20	22·40	26·75	35·97	45·99
	Total	100·00	100·00	100·00	100·00	100·00	100·00
7	Insoluble matter	0·027	0·061	0·057	0·025	0·056	0·040
8	Lime (CaO)	0·052	0·048	0·055	0·055	0·039	0·045
9	Phosphoric acid (P_2O_5)	0·18	0·21	0·28	0·17	0·18	0·26
10	Nitrogen (N)	0·46	0·62	0·59	0·48	0·44	0·51

According to the Government Agricultural Chemist, the figs are a sustaining food, rich in reducing sugars and other carbohydrates and contain fair quantities of protein and minerals.

Banana flour The results of chemical analysis of banana flour as carried out at Coimbatore and Coonoor are given in Tables IV and V.

In both cases corresponding values for a few other staple foods are also presented for comparison.

TABLE IV Results of analysis done at the Nutrition Research Laboratories, Coonoor—Banana flour

No.	Head of analysis	*Karpura chakkara-keli* flour from ripe fruit	*Bontha Ashy* flour from unripe fruit	Mauritius flour from unripe fruit	Arrow root flour (West Indian)	Tapioca	Potato	Goa potato
1	Moisture	9·81	12·42	11·11	16·5	59·4	74·7	74·87
2	Protein	4·58	3·37	4·92	0·2	0·7	1·6	2·46
3	Fat (Ether extractives)	1·72	0·49	0·19	0·1	0·2	0·1	0·21
4	Mineral matter	2·35	1·66	2·61	0·1	1·0	0·6	1·06
5	Carbohydrates	81·54	82·06	81·17	83·1	38·7	22·9	21·40
6	Calcium (Ca)	0·035	0·017	0·017	0·01	0·05	0·01	0·006
7	Phosphorus (P)	0·042	0·019	0·033	0·02	0·04	0·03	0·013
8	Iron (Fe)	4·3	3·0	4·8	1·0	0·9	0·7	1·4
9	Calorific value per 100 gm.	360	346	346	334	159	99	97

TABLE V

Results of analysis done at the Agricultural College and Research Institute, Coimbatore, of flour from unripe fruits

Head of analysis	*Karpura chakkarakali*	*Bontha Ashy*	Mauritius	*Pedda pacha arati*	*Nay poovan*	*Bathees bontha ashy*	*Bathees bontha green*	*Bontha green*	*Nendran*	*Nalla chakkarakali*	*Mala vazhai*	*Nendra padathi*	*Karun kadali*	Mean for banana	Rice	Wheat	Potato	Tapioca
Moisture	8·03	8·99	7·25	7·83	7·30	7·46	8·25	7·85	7·83	7·13	7·11	7·73	7·58	—	—	—	—	—
Ash	3·29	2·31	3·45	3·93	2·71	2·92	4·58	2·98	2·98	3·52	3·18	2·91	3·24	3·50	1·02	2·56	4·03	2·06
Crude protein	3·32	3·04	3·49	6·44	2·88	3·47	5·74	3·29	3·15	4·92	3·16	3·72	5·86	4·38	7·73	18·74	9·76	5·00
Crude fibre	1·03	0·95	0·56	0·57	0·59	0·84	2·33	1·15	0·73	0·79	0·85	0·75	0·78	1·00	0·46	1·69	2·74	1·62
Ether extractives	0·81	0·49	0·48	0·69	0·66	0·51	0·76	0·40	0·48	0·59	0·62	0·62	0·53	0·64	0·84	2·69	0·57	0·27
Carbohydrates (by difference)	83·52	84·22	84·77	80·54	85·86	84·80	78·34	84·83	84·33	83·05	85·08	84·27	82·01	90·48	89·95	74·32	82·90	91·05
Insolubles	0·122	0·014	0·039	0·098	0·008	0·057	0·086	0·034	0·020	0·032	0·072	0·079	0·031	—	—	—	—	—
Lime (CaO)	0·062	0·037	0·040	0·046	0·056	0·036	0·090	0·038	0·048	0·041	0·059	0·053	0·038	0·05	0·03	0·13	0·13	0·15
Phosphoric acid (P_2O_5)	0·373	0·218	0·236	0·208	0·225	0·390	0·517	0·382	0·282	0·306	0·240	0·242	0·194	0·33	0·46	1·21	0·54	0·22

The Director, Nutrition Research, Coonoor, has inferred that banana flour both from the ripe and unripe fruit containing as it does some 3·4 to 5·0 per cent of protein, is by no means a poor source of this food factor. Its calorific value is good and it is also not a negligible source of minerals. Further, it contains some vitamin B_1. He, thererefore concludes that banana flour is superior to arrowroot flour and also to tapioca, allowing for the difference in moisture content. He suggests that banana flour production should be encouraged particularly as a food for young children. The flour is quite palatable and its sweetish taste would probably appeal to children.*

On the other hand, the Government Agricultural Chemist, Coimbatore infers that the varieties differ with wide limits in nutritive value, flour from unripe *Bathees Bontha Green* being specially mentioned by him as being rich in protein as well as minerals. On comparing the average analysis of 13 varieties of flour from unripe fruits with rice, wheat, potato and tapioca he infers, that banana flour from unripe fruits, though a useful food, cannot stand a comparison with other foods except tapioca, in protein and mineral contents.

In the case of banana figs the reducing as well as total sugars are slightly higher than in the case of flours from the corresponding varieties of bananas. The mineral contents of the flour and figs for any of the varieties analysed are not significantly different.

Although banana flour cannot stand comparison with such staple foods as wheat, rice or potato in its protein and mineral contents, it possesses certain valuable auxiliary food factors such as vitamin B_1 and vitamin C, and also available iron to a fair degree. It is these factors and not the protein content alone that have led certain authorities to recommend the production of dehydrated banana products as 'childrens' food. While banana flour may not replace staple food like rice or wheat, it should certainly help as a valuable substitute for the staple foods in times of scarcity. There is no doubt that it deserves popularization in preference to tapioca and arrowroot flours.

In regard to the food value of banana flour a writer in a Jamaican Journal (*The Journal of the Jamaican Agricultural Society, September 1941, page 334*) asserts that it is superior in carbohydrates to wheat flour but inferior in protein or flesh-forming values, very palatable and particularly adapted to persons of weak digestion organs. He refers to cases of patients who were unable to keep down milk or other foods, but easily kept down banana flour made into a thin gruel and flavoured with lemon or lime juice and sweetened with sugar. He adds that the starch in it is particularly easy of solution and digestion in the alkaline juices of the body. Banana meal is also reported by him to be used with safety by persons who do not want to put on flesh but wish to be fit and strong.

* **It is being used as food for children in some parts of this province.—*Ed.***

Use of banana flour and fig Attempts have been made to work out methods of preparing from the banana flour and fig a large number of appetising dishes and beverages. The results of these attempts have disclosed numerous possibilities which remain yet to be fully exploited. A number of recipes which have already been tested are being published in the form of a Departmental Leaflet.

Acknowledgment Sri C. Bhujanga Rao, First Assistant, Fruit Research Station, Kodur, has assisted the author in the conduct of some of the investigations reported in this paper. The Director, Nutrition Research, Coonoor, and the Government Agricultural Chemist, Coimbatore, were responsible for carrying out the vitamin tests and chemical analyses Dr. G. S. Siddappa, Bio-Chemist, Kodur, has taken the trouble of reading through the manuscript and suggesting improvements in the text. To all these the author's grateful thanks are due.

Effect of Seed Treatments on the Germination of Paddy

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That the cultivation of paddy suffers, often considerably, from the attack of various diseases is well known in India and elsewhere. Attempts are therefore made to prevent or control their damage through various means, viz., through propagation of more resistant varieties, seed treatment, or spraying (or dusting) the standing crop with fungicides. Seed treatment being a cheap and easy method, is within the reach of common cultivators, who, being proverbially poor, are unable to pay for the cost of fungicides and the spraying outfits apart from the question of labour that is necessary to spray large areas. Further, the quantity of fungicide that would be required for seed treatment is infinitesimally small in comparison with the quantity that would be required for spraying fields grown out of the same quantity of seeds. From these considerations agricultural workers are now paying more attention to develop seed treatment as a practical means to combat the diseases. Attempts have, therefore, been made in the present investigation to ascertain whether the chemicals used for treatment have got any detrimental effect on the germination of seeds and, if so, to modify the seed rate in sowing accordingly.

Transplanted *Aman*, var. Chinsura 72, was selected for the purpose. Seed treatments* were done with the following chemicals, that are commonly used in Bengal:—

A—Agrosan G
B—Bordeaux mixture, 1% for 10 minutes
C—Copper sulphate solution, 2% for 30 minutes
D - Formalin (aqueous) solution, 2% for 15 minutes

* The seeds were treated 24 hours ahead of sowing and the lots that were treated with liquid fungicides were dried in the sun after the period of treatment was over.