LXVII. THE VITAMINS (A, B, AND C) OF PAPAYA.

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THE papaya (*Carica Papaya* L.) is an important fruit in many tropical countries. In the Hawaiian Islands, the papaya, pineapple and banana are the fresh fruits locally grown which are available the year round. Papaya is easily grown, is a cheap fruit and is used in large quantities by all economic classes.

Since the experiments here reported were begun, the vitamins of papaya have been reported on elsewhere. Acuña [1923] from the Philippines reported on the vitamin B content, but his work is difficult to evaluate as the rats weighed from 160 to 200 g. when feeding of papaya was begun. The age of the animals is not stated. The amounts of papaya fed varied, being increased at irregular intervals from 1 to 40 g. Six rats are reported as being used.

Donath [1925] fed an exclusive rice diet to rats, supplementing it with some Indian food stuffs to determine their vitamin A content. The abstract gave no indication of the number of rats used. One g. of papaya was said to cure xerophthalmia caused by the rice diet.

Embrey [1923], reporting on the antiscorbutic vitamin of some oriental fruits and vegetables, fed 10 g. of raw papaya daily to four guinea-pigs. Two pigs died in 5½ weeks, two others lived 9 weeks.

The percentage composition of papaya in Hawaii according to available data [Report, 1914] is:

Water	Fat	Protein	Carbohydrate	Crude fibre	Ash
86.51	0.105	0.488	10.6	0.66	0.76

The papaya is an important source of papain, a proteolytic enzyme.

VITAMIN A.

The following basal diet was used:

Meat residue ¹	...	...	...	...	20 %
Starch	...	...	...	...	53
Yeast (Fleischmann, dry)	...	...	...	...	3
Fat (Crisco)	...	...	...	...	20
Salt mixture ²	...	...	...	...	4

¹ Prepared as directed by Osborne, Wakeman and Ferry [1919].

² Prepared as directed by Osborne and Mendel [1919].

Young rats weaned at 28 or 29 days were placed on this diet. When the weights of the animals had declined, usually in about 4 weeks, the feeding of a weighed amount of fresh papaya daily was begun. Five g. were fed to four rats, 10 g. to four rats, 15 g. to two rats and 20 g. to six rats. One female fed for a period of 21 weeks produced a litter of 3 which died. A second female fed 16 weeks, produced two litters of 5 and 7 each. The second litter of 7 were alive and active, but stunted, at the end of 4 weeks when they were killed. The results are summarised in Table I.

Table I. *Showing results of feeding papaya for vitamin A.*

Rat No.	Weight of fresh papaya fed daily g.	Initial weight of rat g.	Weight when papaya feeding was begun g.	Weight at end of experiment g.	Period fed weeks
179 ♂	5	58	83	128	8
181 ♀	5	56	70	111	8
185 ♀	5	50	60	111	8
186 ♀	5	48	57	98	8
183 ♀	10	51	59	105	8
184 ♀	10	50	58	101	8
180 ♂	10	57	69	154	8
182 ♀	10	52	73	145	8
195 ♂	15	43	71	175	8
196 ♀	15	43	65	145	8
218 ♀	20	57	83	182	14
220 ♀	20	47	72	161	14
194 ♂	20	53	82	198	16
197 ♀	20	42	78	155	16
217 ♂	20	61	85	260	21
219 ♀	20	56	89	216	21

Ordinarily two rats were kept in a cage and records of food consumption of basal diet were made for the two. The rats were separated each day when the papaya was fed. The mothers of all experimental rats used were fed with Sherman's stock diet of one-third whole milk powder, two-thirds whole ground wheat, and salt equal to 1 % of the weight of the wheat.

VITAMIN B.

The following basal diet was used:

Meat residue ¹	...	...	...	...	20 %
Starch	...	...	...	...	61
Fat: Butter fat	...	...	...	...	10
Crisco	...	...	...	...	5
Salt mixture ¹	...	...	...	...	4

Rats raised as indicated above were placed on this diet at the age of 28 or 29 days for 2 weeks, when papaya feeding was begun. Five g. of papaya were fed to two rats, 10 g. to two rats, 15 g. to two rats, and 20 g. to six rats. Almost normal growth was obtained on 20 g. only. The results are summarised in Table II.

¹ Prepared as indicated under vitamin A.

Table II. *Showing results of feeding papaya for vitamin B.*

Rat No.	Weight of fresh papaya fed daily	Initial weight of rat	Weight when papaya feeding was begun	Weight at end of experiment	Period fed weeks
	g.	g.	g.	g.	
204 ♂	5	66	62	77	9
206 ♀	5	64	64	67	9
205 ♂	10	59	60	90	9
207 ♀	10	61	63	87	9
208 ♀	15	59	62	112	11
209 ♀	15	58	59	114	11
212 ♂	20	64	67	173	10
214 ♀	20	59	64	141	10
213 ♂	20	58	64	150	10
216 ♀	20	57	65	125	10
210 ♀	20	57	61	128	10
211 ♀	20	54	50	123	10

All rats were kept in wire mesh cages with the bottoms raised one inch above the pan to reduce the consumption of faeces to the minimum.

VITAMIN C.

Guinea-pigs raised especially for feeding experiments were used. Sherman's recommendation for procedure [Sherman and Smith, 1922] was followed. Pigs between 300 and 350 g., 6 to 8 weeks old, were placed on the following diet plus fresh alfalfa:

Whole oats ground as needed...	...	...	...	59 %
Skimmed milk powder (Klim) heated in open trays at 110° for 2½ hours	...	...	...	30
Butter fat	...	...	...	10
Sodium chloride	...	...	...	1

When alfalfa is withdrawn, the weights go down, then up, then down again at the onset of scurvy. Seven guinea-pigs were fed 5 g. of fresh papaya daily. The pigs were all completely protected from scurvy. Their gains in weight were remarkable, as shown in Table III. Autopsies showed all the pigs to be in excellent condition when killed. One guinea-pig was fed 3 g. of fresh papaya daily for 12 weeks and gained as well as those on 5 g. The minimum for protection was therefore not discovered.

Table III. *Showing results of feeding papaya for vitamin C.*

Guinea-pig No.	Weight of fresh papaya fed daily	Initial weight of guinea-pig	Weight when papaya feeding was begun	Weight at end of experiment	Period fed weeks
	g.	g.	g.	g.	
73 ♂	5	359	347	636	12
69 ♂	5	353	320	575	10
75 ♂	5	338	312	551	12
96 ♀	5	340	358	503	12
83 ♂	5	327	312	540	12
37 ♂	5	344	371	552	14
64 ♀	5	301	270	475	14
81 ♂	3	358	330	577	12

PIGMENTATION.

As papaya has a bright orange colour, an attempt was made to identify the pigment. The method suggested by Palmer [1922] for the quantitative determination of carotene and xanthophyll was used with slight modifications. What appeared to be pure carotene crystals were finally obtained but no xanthophyll. Further work on the pigments of papaya is needed.

CONCLUSIONS.

The papaya is only a fair source of vitamin B, a good source of vitamin A and an excellent source of vitamin C.

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