

## Effect of cassava bread supplementation on energy intake of rats

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**SUMMARY.** The effect of supplementing semi-purified diet of rats with milled cassava bread was investigated. Total food intake and weight gain were measured in *ad libitum* and *pair fed* animals. Plasma triglyceride levels were determined at the beginning and end of the experimental period. Cassava bread supplementation did not increase total food intake of the animals therefore resulted in a lower food efficiency ratio (FER) of the diet when animals were fed *ad libitum*. When the animals were *pair fed*, FER was similar for both diets suggesting that cassava supplementation does not increase significantly the energy content of the diet. Addition of milled cassava bread to the diet did not modify plasma lipid levels. This results support that cassava starch is partially unavailable to the rats. Clinical use of cassava bread is suggested for diabetic and obese patients.

**RESUMEN.** Efecto del cazabe sobre la ingestión de energía de la rata. Se investigó el efecto de la suplementación de una dieta semi-purificada con cazabe. Se evaluó la ingestión total de alimentos y la ganancia de peso de los animales sometidos a dos modelos de administración de la ración alimenticia: «libremente (*ad-libitum*)» y «apareamiento dietario (*pair-fed*)». Los niveles de triglicéridos plasmáticos fueron determinados al comienzo y final del período experimental. Los resultados demuestran que cuando los animales ingerían la ración libremente la suplementación de la dieta con cazabe no aumentó la ingestión total de alimentos por lo cual la eficiencia de la dieta (FER) disminuyó. En los experimentos de alimentación apareada la eficiencia de las dietas fue semejante por lo que se propone que la suplementación de la dieta con cazabe no aumentó el contenido energético de la ración alimenticia en forma significativa. No hubo diferencias significativas en los niveles de triglicéridos plasmáticos entre los grupos experimentales. Estos resultados sugieren que el almidón contenido en el cazabe es poco utilizable por los animales como fuente de energía. Se propone el uso de este alimento en pacientes diabéticos y obesos.

### INTRODUCTION

Cassava is an important component of the diet in tropical countries (1). In Venezuela the most common way of eating cassava is as a dry bread: «cazabe» (2), which has an 86% starch content with a relatively low starch digestibility index

(3) and a dietary fibre content of 5.6% insoluble and 3.8% soluble fibre. The soluble fraction is rich in uronic acid polysaccharides hence it might be expected to modify the viscosity of the aqueous media of the intestine, and it has been shown (4) that cassava bread fibre delays gastric emptying in rats. It is generally accepted that certain dietary fibres, and particularly those considered soluble and gel forming, can modify the rates of absorption of various nutrients (5) therefore, dietary fibre has been used in the treatment of obesity (6). In the present study the possibility that cassava bread supplemented diet may modify the caloric value of the portion and thereby change the food efficiency ratio of the diet was explored. Possible effects of cassava bread supplementation on triglyceride plasma levels were also investigated.

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## MATERIALS AND METHODS

**Cassava bread.** Samples were purchased from a city market at Caracas, Venezuela. The bread was milled to pass through a 6- mesh screen and kept dry.

**Animal feeding.** For each experiment 20 females Sprague-Dawley rats (IME-UCV) were randomly assigned to two experimental groups of 10 animals each. Both groups had similar mean body weight at the beginning of the experiment («ad libitum» experiments:  $190 \pm 15$  g; «pair fed experiments»:  $185 \pm 10$  g.). All animals were housed individually in suspended stainless steel wired bottomed cages, and given tap water *ad libitum*. Animals were fed *ad libitum* or *pair fed* as indicated below.

**Diets.** Diets were prepared milling rat chow (Ratarina®) to pass through a 60 mesh screen, and mixing it with 20% (w/w) commercial mixed vegetable oil (control diet). Milled cassava bread was added (20% w/w) to half of the control diet (Cassava diet=100 parts control diet+20 parts milled cassava bread). Both diets were kept dry at 2 °C.

**Feeding procedures.** Animals were fed either a control or a 20% cassava supplemented diet. For the first experiment rats had free access to food. In the *pair fed* experiments animals

were matched and the food intake of the rats receiving control diet was limited by the amount of control portion taken by the experimental pair, therefore cassava free portion intake for both groups was similar.

Animals were weighed daily and food intake calculated considering feed spillage.

**Blood collection.** All blood parameters were determined individually in tail blood samples taken at the beginning and end of the experimental period.

Plasma triglycerides levels were assayed according to the enzymatic method of Tiffany et al. (7) with a commercial kit (Boehringer-Mannheim<sup>R</sup>).

## RESULTS

## I. Ad libitum fed animals.

Table 1 shows that there were no significant differences in total food intake between control and cassava fed animals for the experimental period. When calculated on the basis of the cassava free portion, food intake was significantly lower in animals fed cassava supplemented diet, no matter the time period considered. The weight gain of the supplemented group is always smaller than that of the control animals; this difference reaches statistical significance ( $p < .05$ ) after the second week of supplementation.

TABLE 1  
FOOD INTAKE AND WEIGHT OF RATS FED AD-LIBITUM FOR FOUR WEEKS

		Total	Food intake (g)		Weight (g)	Weight gain (g)
			Cassava	Cass, free		
First week	Control	119±6	—	119±6	242±18	52±2
	Cassava	128±6	26	102±4*	237±17	47±1
Second week	Control	119±5	—	119±5	285±19	43±2
	Cassava	125±6	25	100±4*	274±20	37±2
Third week	Control	121±6	—	121±6	326±35	43±2
	Cassava	118±4	23	95±4*	306±28	32±1*
Fourth week	Control	162±6	—	162±7	367±30	42±2
	Cassava	157±6	31	126±6*	343±22	34±1*

Values are mean ± SD of 10 animals.

Cass. Free = Cassava free portion of the diet in g.; \*= $p < .05$

Figure 1 shows the food efficiency ratio (FER) of the diets for each experimental period. This parameter was significantly higher for the group fed control diet during the whole period studied, difference being statistically significant ( $p < .05$ ). When FER is calculated on a cassava free portion basis the efficiency of the experimental diet becomes similar to that of control diet for the first three weeks. During the fourth week the efficiency for the cassava diet, calculated on cassava free portion, becomes higher than that of the control.

FIGURE 1

Food efficiency ratio in rats fed ad-libitum for four weeks

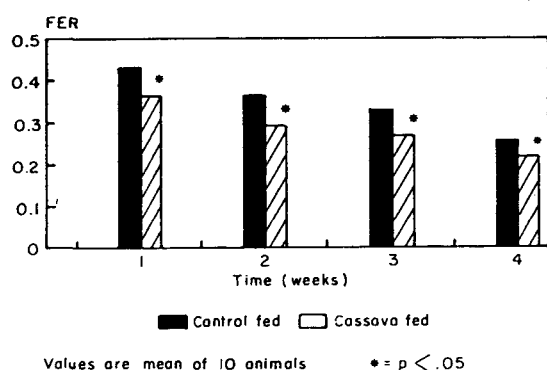


Table 2 summarizes plasma triglyceride mean values for control and experimental (cassava supplemented) animals and shows that there were no significant differences between the groups.

TABLE 2  
TRIGLYCERIDE PLASMA LEVELS OF RATS FED  
AD-LIBITUM FOR FOUR WEEKS

	(mg/100ml)	
	Initial	Final
Control	43.9 ± 3.0	35.0 ± 2.9
Cassava fed	44.7 ± 2.1	39.5 ± 2.2

Values are mean ± SD of 10 animals

## II. Pair fed animals

Food intake and weight gain of rats pair fed the two diets for three weeks are summarized in Table 3. Total food intake was always 20% higher for cassava fed animals in order to provide a similar intake of the cassava free portion, thus when food intake was calculated on cassava free basis no difference was found between the groups.

TABLE 3  
FOOD INTAKE AND WEIGHT OF RATS PAIR-FED  
FOR THREE WEEKS

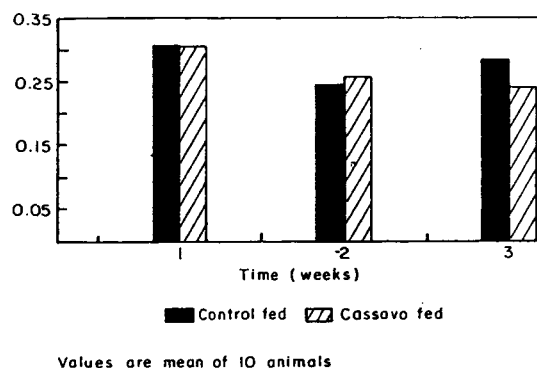
		Food intake (g)		Weight W. gain (g)	
		Total	Cassava free		
First week	Control	74±2	—	74±2	190±3 23±3
	Cassava	95±3	19±2	76±2	191±3 29±2
Second week	Control	68±2	—	68±2	208±3 17±3
	Cassava	82±2*	16±2	66±2	213±3 21±3
Third week	Control	87±3*	—	87±3	233±4 25±3
	Cassava	106±2*	21±2	85±3	240±3 26±3

Controls received 80% of the cassava ratio.  
Values are mean ± SD of 10 animals; \* =  $p < 0.5$

Regarding FER, Figure 2 shows that there were no significant differences between the groups.

FIGURE 2

Food efficiency ratio in rats pair-fed for three weeks



Plasma triglyceride values were similar in supplemented and control fed animals (Table 4).

TABLE 4  
TRIGLYCERIDE PLASMA LEVELS OF RATS  
PAIR-FED FOR THREE WEEKS

	Initial	(mg/100 ml)		
		W1	W2	W3
Control	45.2 ± 3.8	33.3 ± 4.7	30.1 ± 3.1	30.5 ± 3.9
Cassava fed	46.5 ± 4.7	44.6 ± 5.3	43.1 ± 3.2	37.2 ± 2.0

Values are mean ± SD of 10 animals. W = time in weeks.

## DISCUSSION

Previous studies have shown that cassava bread has a starch content between 86-87% with an slower rate of *in vitro* starch hydrolysis than that of boiled wheat starch (3). Since soluble fiber accounts for a significant (4) part of Total Dietary Fiber (TDG) in this bread, the possibility of a diet dilution effect when supplementing diets with cassava bread was studied in two different experimental conditions: *ad libitum* and pair fed groups.

The results show that although cassava supplementation implies an increase in the starch and fibre content of the diet, the differences on food intake of the animals were non significant when fed *ad libitum*. Moreover the weight gain of the experimental group is significantly lower than that of the control animals and the calculated food efficiency ratio is lower for the supplemented diet. Therefore, the results suggest that cassava bread supplementation did not increase significantly the available carbohydrate content fo the diet, but produced a dilution effect that could not be compensated by the animals. This results agree with previous reports (3) which showed a lower *in vitro* digestibility for cassava bread and suggest, that *in vivo* cassava bread digestibility is also low.

The fact that Triglyceride plasma levels are similar for both groups at the end of the experimental period also suggest that there was no functional difference regarding carbohydrate absorption (8), which also means that cassava starch was not available to the rats. The fact that FER calculated on a cassava free portion basis becomes higher at the end of the experimental period could suggest the possibility of an adaptation mechanism for cassava starch digestion in the supplemented animals.

The results of the pair fed experiments suggest that cassava supplement contributed poorly to the energy intake of the animals as shown by the non significant difference of weight gain between the groups. This result supports the hypothesis that *in vivo* cassava starch is partially unavailable to the animlas, hence food efficiency ratio becomes similar for the pair fed group, showing that the FER difference between the groups, when animals were fed *ad libitum*, was due to differences in food intake that are not present when the ingestion of cassava free diet is similar. This result suggest that cassava starch does not contribute significantly to the available energy content of the diet and that cassava supplementation produces a satiety effect that prevents compensation of lower energy intake by increasing total food intake on *ad libitum* fed animals.

The lower efficiency of the cassava bread supplemented diet in the *ad libitum* experimental condition might be due to either the dietary fibre content of the bread or to limited availability of the cassava starch. The dietary fibre contained in cassava bread may enhance the unstirred water layer of the intestine and diminish glucose absorption (9). Another possibility is that cassava starch is resistant to hydrolysis (resistant starch) (10) or has non-starch/starch interactions which reduce starch availability (11,12).

The fact that triglyceride plasma levels are similar for both experimental designs reinforces the idea of unabsorbed cassava starch.

This results suggest that supplementing the diet of obese and diabetic patients with cassava bread might be useful as a dietary therapeutic tool in tropical countries. The glycaemic response of rats to cassava supplementation will be discussed in another paper.

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