

Rate of *in vitro* Digestion of Some Nigerian Foods by Salivary α -Amylase: Implications for the Management of Post-Prandial Glucose Levels.

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ABSTRACT

The effect of oil on the rate of digestion of boiled ripe and unripe plantain, as well as comparative effects of three Nigerian soups on the rates of digestion of plantain and cassava flours, by salivary α -amylase, was investigated. There was a reduced rate of digestion and sugar release from the ripe and unripe plantain in the presence of oil, an effect that was more pronounced on the unripe plantain. Comparatively, the rate of liberation of sugars was highest in the plantain flour, followed by the ripe plantain and lowest in the unripe plantain. The soups remarkably and comparably, lowered the rate of digestion and release of sugars from both cassava and plantain flours, with ogbono soup consistently eliciting the highest effect. Our results suggest that these soups may be useful in the management of diabetes mellitus.

(Keywords: dietary management, digestion, Nigerian soups, oil, salivary α -amylase)

INTRODUCTION

The prevalence of obesity and degenerative diseases like diabetes mellitus and cardiovascular diseases (CVD) is rapidly increasing, especially in young individuals. According to experts, nutritional habits play a decisive role in increasing the burden of these chronic conditions. Therefore, modifying dietary habits could exert a positive impact in the prevention and treatment of these diseases. It has been suggested that the state of hyperglycaemia that is observed following food intake under certain dietary regimes could constitute a risk factor for the development of various metabolic conditions [Jenkins *et al.*,

2008]; especially in patients with poor glycaemic control such as in diabetes mellitus, and even healthy individuals. Under such circumstances, it would be helpful to be able to reduce the amplitude and duration of post-prandial hyperglycaemia.

Some carbohydrate rich foods induce less post-ingestive hyperglycaemia than others. Therefore, selecting the right kind of carbohydrate foods could actually represent a strategy in the prevention and treatment of chronic metabolic disorders [Brand *et al.*, 1991; Roder *et al.*, 2005; Jenkins *et al.*, 2008]. Studies show that different carbohydrate foods vary in the rate at which they release their products of digestion and that the rate of digestion bears a significant relationship to the degree to which they raise the blood glucose [Björck *et al.*, 1994; Jenkins *et al.*, 1982, 1987, 2008; O'Dea *et al.*, 1981]. There is a significant relationship between glucose trapping and the percentage carbohydrate digested at 5h. Soluble fibres flatten the blood glucose response following oral glucose tolerance tests, due to their ability to decrease the rate of digestion and gastric emptying [Jenkins *et al.*, 1978, 1982, 2008; Trivedi *et al.*, 1999; Chandalia *et al.*, 2000; Flammang *et al.*, 2006].

Since, a reduced rate of digestion and/or absorption leads to a lower and prolonged increase in post-prandial glucose levels and hence to a lower insulin response, foods which bring about a lower and gradual increase in post-prandial glucose should improve impaired carbohydrate tolerance in diabetics [Jenkins *et al.*, 1980, 1987 1998, 2008; Roder *et al.*, 2005]. This should consequently be taken advantage of in making recommendations for the dietary management of both diabetics and non-diabetics.

Sequel to this, the present study was designed in order to elucidate the effect of oil on the rate of digestion of boiled ripe and unripe plantains; compare the rate of digestion of ripe and unripe plantain, plantain and cassava flour, as well as the effects of three Nigerian soups on the rates of digestion of plantain and cassava flours, by salivary α -amylase.

MATERIALS AND METHODS

The plantain (ripe and unripe), cassava and plantain flours were purchased from Uselu Market in Benin City, Nigeria. The soups: "egusi" soup, "ogbono" soup and "pepper" soup were purchased from Uniben Staff Canteen, next to the Admission Office, University of Benin, Benin City, Nigeria. All reagents are of analytical grade (Table 1).

After thoroughly washing the mouth with distilled water, 5 minutes later, it was rinsed with 10mL of water and the content poured into a flask. The rinsing was repeated seven consecutive times, and the saliva collected was mixed properly and stored for use in the study. The ripe and unripe plantains were peeled, sliced and cooked until softened, with salt added to taste. Then, 2g of each were weighed and homogenized in a mortar. The cassava and plantain flours were each reconstituted by boiling in water and cooking with continuous stirring until a thick smooth paste was formed.

To 2.0g each of the homogenized ripe and unripe plantains in a beaker, was added 10mL of the saliva. The mixture was made up to 30mL with distilled water, before transferring it into a dialysis tube which was placed in a beaker containing 800mL of distilled water. Another 2.0g each of the homogenized ripe and unripe plantains were thoroughly mixed with 1mL of oil, before adding 10mL of the saliva and making up to 30mL with distilled water. This was transferred into a dialysis tube which was then placed in a beaker containing 800mL of distilled water.

The cassava and plantain flour pastes were treated as above, with the soups (ogbono, egusi and pepper soups) in place of the oil. These were allowed to stand, and dialysates were collected at hourly intervals after stirring, the reducing sugar content was estimated by the Somogyi method, as reported by Plummer [1978].

RESULTS AND DISCUSSION

Figures 1-2 shows the time course of the effect of oil on the rate of digestion of ripe and unripe plantain, and time course of the effect of nature and processing on the rate of digestion of plantain starch, respectively. The rate of liberation of sugars was highest in the flour, and lowest in the unripe plantain (Figure 2). This difference may probably be due to post-harvest changes (e.g. ripening), storage conditions and processing history [Roder *et al.*, 2005; Vosloo, 2005].

Table 1: The Components of the Three Nigerian Soups.

Egusi Soup	Ogbono Soup	Pepper Soup
Water	Water	Water
Oil	Oil	Oil
Pepper	Pepper	Pepper
Salt	Salt	Salt
Seasoning	Seasoning	Seasoning
Vegetable	Vegetable	Vegetable
Fish and/or meat	Fish and/or meat	Fish and/or meat
Melon (egusi)	Dika nut kernel (ogbono)	-

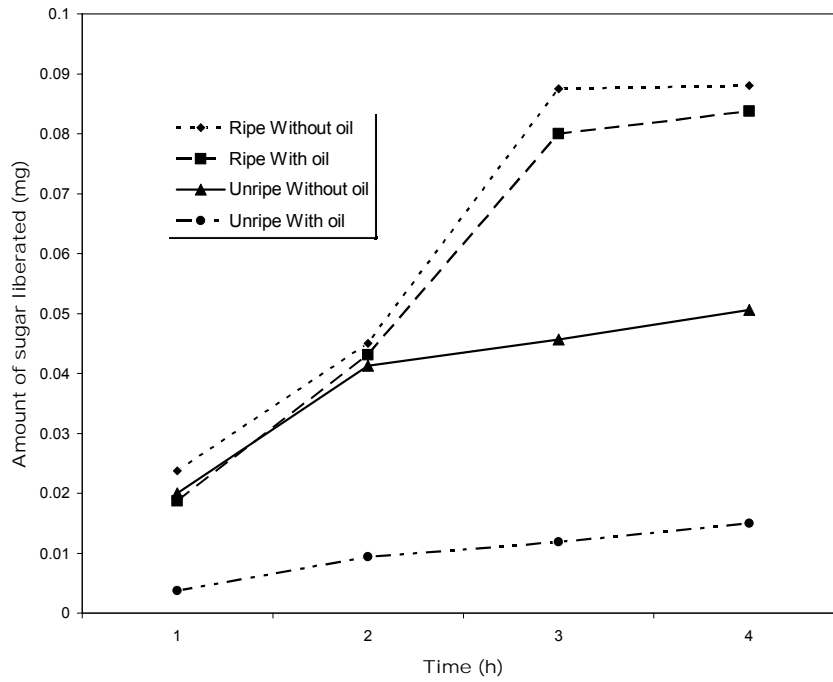


Figure 1: Course of the Effect of Oil on the *in vitro* Digestion of Ripe and Unripe Plantain.

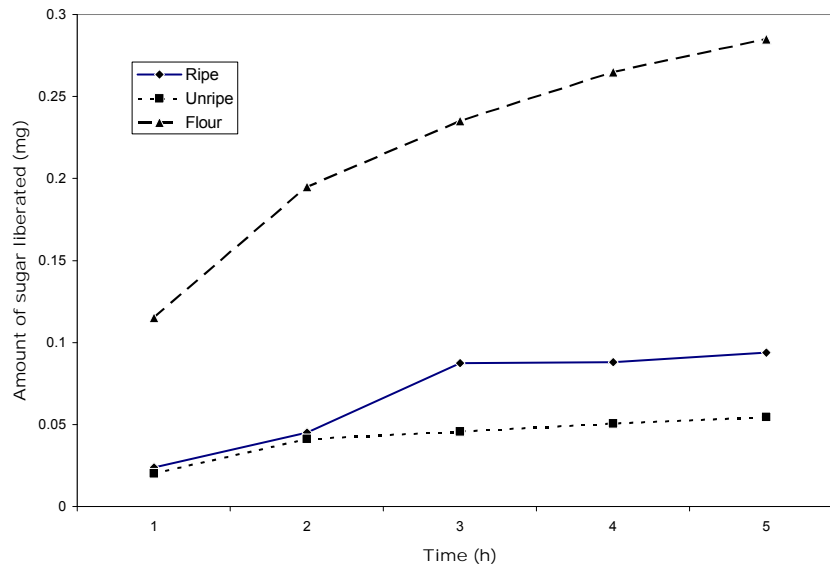


Figure 2: Time Course of the Effect of Post-Harvest State and Processing History on the Rate of Digestion and Sugar Release from Plantain Starch.

According to Marriott *et al.* [1981], the starch content of plantain is converted to sucrose, glucose and fructose upon ripening. As a consequence of the various factors that can influence the granule integrity and gelatinization properties, different starchy foodstuffs that are subjected to differing regimes during processing and/or cooking and contain other ingredients such as sucrose, are likely to contain starch of very dissimilar properties. The dissimilarities will then impact on the susceptibility of the material to digestion [Roder *et al.*, 2005; Vosloo, 2005]. Furthermore, processing (to flour) may disrupt the starch-protein interactions, thereby enhancing the rate of digestion and release of sugars from their starch [Jenkins *et al.*, 1987; Vosloo, 2005]. These differences may also be accounted for by the differences in origin and/or the presence of anti-nutrients [Roder *et al.*, 2005; Vosloo, 2005].

There was a reduced rate of digestion and sugar release from the ripe and unripe plantain in the presence of oil, an effect that was more

pronounced on the unripe plantain. This can be explained by the fact that the oil encapsulates the starch granules thus decreasing their availability to the enzyme and consequently, their rate of digestion [Holm, 1988; Vosloo, 2005]. The decreased rate of digestion can also be explained on the basis of the effect of the oil on the viscosity of the meal. Oil increases the viscosity, thus decreasing enzymic availability [Jenkins *et al.*, 1978; Vosloo, 2005]. This of course will make for a lower and prolonged post prandial glucose level and insulin demand [Jenkins *et al.*, 1980], and will be beneficial to the diabetic. The effect of origin on the rate of sugar liberation is further illustrated in Figure 3.

The effect of the three Nigerian soups on the rate of digestion of plantain and cassava flours is shown in Figures 4-5. Taking into cognizance, the differing carbohydrate compositions of plantain and cassava flours, emphasis here is on the differential effects of the three soups.

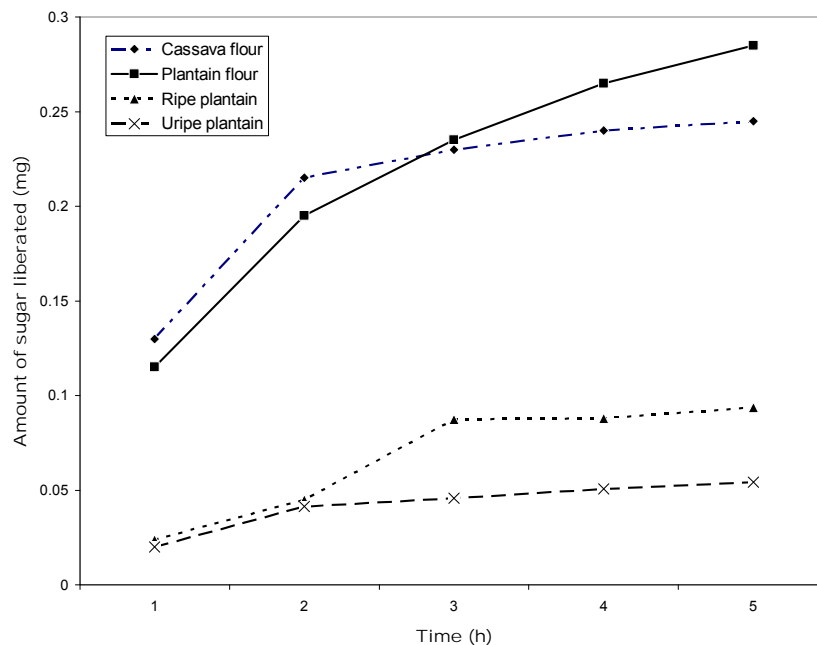


Figure 3: Time Course of the Effect of Origin/Source/Nature on the Rate of Digestion of Starch.

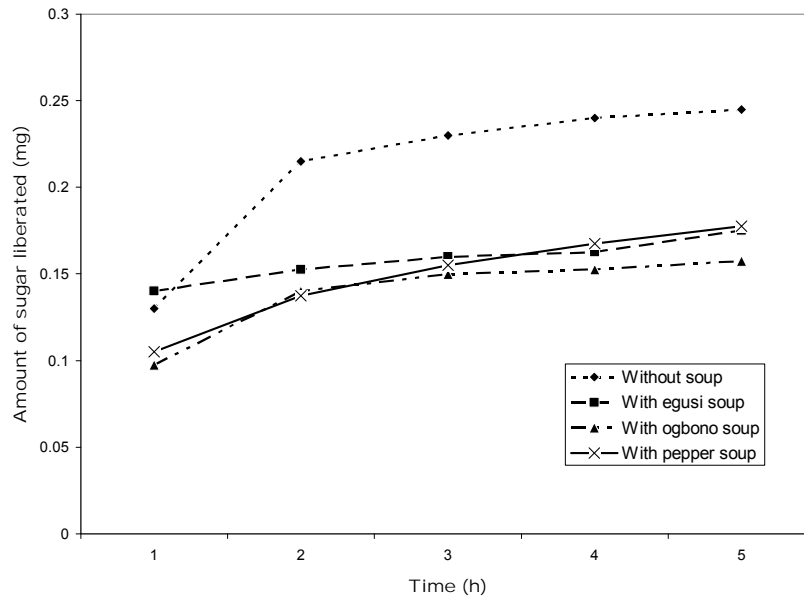


Figure 4: Time Course of the Effect of Some Nigerian Soups on the Rate of Digestion of Cassava Flour.

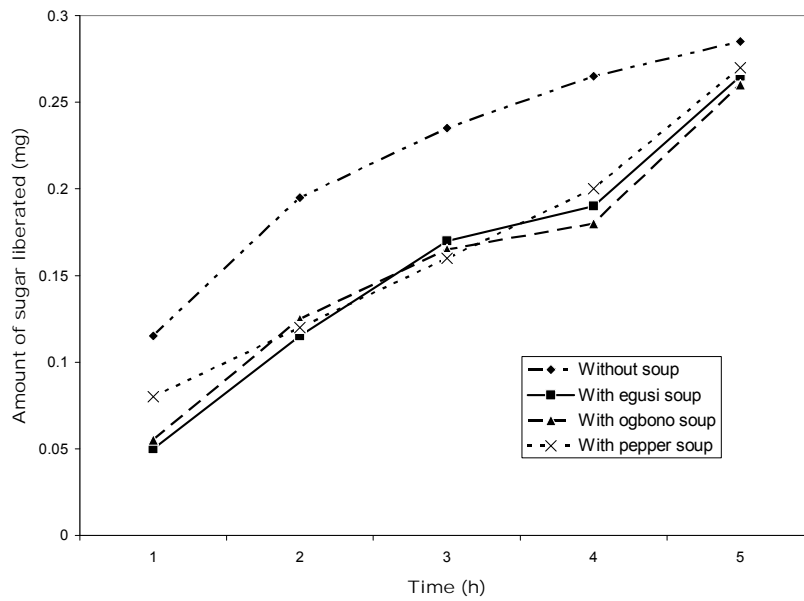


Figure 5: Time Course of the Effect of some Nigerian Soups on the Rate of Digestion of Plantain Flour.

They remarkably and comparably, lowered the rate of digestion and release of sugars from both cassava and plantain flours, with Ogbono soup consistently eliciting the highest effect. Generally, all three soups contain oil and protein, both of which may be responsible for their reduction of the rate of digestion and release of sugar from the flours [Jenkins *et al.*, 1987; Holm, 1988; Vosloo, 2005]. Oil encapsulates the starch granules, thus decreasing its digestibility and hence the rate of digestion [Jenkins *et al.*, 1987; Holm, 1988; Vosloo, 2005].

The Ogbono soup also contains “ogbono” (a soluble fiber, from dika nut, *Irvingia spp*) which increases the viscosity of the meal, thereby decreasing the enzymic availability (or retarding digestion) and rate of diffusion of glucose from the glucose/fiber mixtures [O’Dea, *et al.*, 1981; Jenkins *et al.*, 1981, 2008; Roder *et al.*, 2005; Vosloo, 2005]. This therefore, means that it will be most appropriate for diabetics, since the decreased rate of digestion and absorption will ensure a slow and prolonged post prandial glucose level and insulin response [Jenkins *et al.*, 1980].

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