

## 1. ABSTRACT

### PHYSICO-CHEMICAL AND FUNCTIONAL PROPERTIES OF GRAIN TEF [*Eragrostis tef* (Zucc.) Trotter] STARCH

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Grain tef is widely used in Ethiopia in various baked foods and local beverages. Food and beverage quality, and other possible non-food applications are affected by tef starch quality.

Starches isolated from five grain tef varieties were characterised and compared with commercial normal maize starch. The starches from the five varieties were similar. Tef starch is compound type granule comprising many simpler individual granules (2–6  $\mu\text{m}$  in diameter). General size is 3–5  $\mu\text{m}$ . Individual granules are smooth surfaced with no surface pores and most are polygonal shaped but a few are cubic.

Tef starch amylose content was in the range 24.9–31.7 %. Endogenous tef starch lipid was slightly lower than maize starch. Protein content was approx. 0.19 %. Phosphorus content (mean 0.65 mg/g) was higher than maize starch but virtually the same as reported for rice starch. Water absorption index (108 %) was higher than maize starch but water solubility index (0.34 %) was lower. The starch swelling power was lower than maize starch but amylose leaching was higher.

Tef starch X-ray diffraction pattern is A type. Granule crystallinity was approx. 37 %, similar to rice and sorghum. *Kofler* hot stage gelatinisation temperature range was 68–80  $^{\circ}\text{C}$  and DSC gelatinisation endotherms: onset ( $T_o$ ), peak ( $T_p$ ) and conclusion ( $T_c$ ) temperatures in  $^{\circ}\text{C}$  and enthalpy ( $\Delta H$ ) in J/g were 64–65, 70–71, 81–82  $^{\circ}\text{C}$  and

2.28–7.22 J/g, respectively. The gelatinisation temperature is typical of tropical cereal starches, resembling normal rice starch. Pasting temperature was similar to maize starch. Cooking time for peak viscosity was slightly longer than maize starch. The intrinsic peak viscosity, breakdown viscosity, cold paste viscosity and setback viscosity were considerably lower than maize starch. Shear breakdown resistance was higher than maize starch. Paste clarity was opaque and similar to maize. The gel texture was short and smooth. Retrogradation tendency (determined as % gel syneresis) was lower than maize starch.

The *in vitro*  $\alpha$ -amylase enzyme mode of attack to native tef starch was by surface erosion, whereas in the maize it was by pitting. However, both are by endocorrosion. Dilute HCl gradually denuded the tef starch granule surface, deformed and fragmented the granules. Initially, tef starch appeared a good substrate for  $\alpha$ -amylase digestion and hydrolysis by dilute HCl, probably in part because of its small granule size and large amorphous portion.

The lower swelling capacity, lower % crystallinity, small gelatinisation enthalpy ( $\Delta H$ ) of tef starch compared to maize starch indicates that in tef starch there is a higher proportion of short amylopectin A chains and a lower proportion of long amylopectin A chains.

The physico-chemical properties of tef starch indicate that it may have good functionality as a fat mimetics, and an aroma and flavour carrier. It may perform better under high shear processing, in frozen and/or refrigerated foods compared to most normal native cereal starches (maize, sorghum, rice and wheat). In non-food industries, it could serve as a pharmaceutical tablet carrier and as a cosmetic dusting agent because of smoothed surface, very small and uniform granule size distribution.