5. CONCLUSIONS AND RECOMMENDATIONS

Tef has compound type starch granules like rice, oats, amaranthus and quinoa. The individual granules are small (2–6 μm in diameter), polygonal shaped of smooth surface and with no surface pores. Amylose/amylopectin ratio of starches isolated from five tef starch varieties is 24.9–31.7 %, which is similar to other normal native maize, sorghum and rice starches. The mean protein content of tef starch is 0.19 %, which is higher than commercial maize starch (i.e. 0.07 % protein). The total lipid content (7.8–9.6 mg/g) of tef starch varieties is quite high but slightly lower than that of maize starch. The phosphorus content is high, similar to rice starch.

The X–ray diffraction pattern of tef starches is A type like other normal cereal starches. The crystallinity level is approx. 37 %, similar to normal rice and sorghum starches. Water absorption index is higher than maize starch and water solubility index is lower. The swelling power is lower than maize starch but amylose leaching is higher than maize starch. The *Kofler* hot stage gelatinisation temperature (68–80 ^{O}C) and DSC gelatinisation temperature (Tp = 70–71 ^{O}C) are high like other normal native tropical cereal starches, and similar to rice starch. The RVA pasting temperature (74 ^{O}C) is similar to normal maize starch and is apparently slightly higher than normal sorghum starch. The RVA peak viscosity is medium and is lower than maize starch but apparently slightly higher than normal rice starch. The breakdown viscosity is lower than maize and probably rice starch. The cold paste viscosity is lower than maize starch but probably slightly higher than rice starch. The setback viscosity is lower than maize and probably rice starch. The retrogradation tendency (refrigeration and freeze storage and freeze–thaw treatments) of tef starch is less than maize starch.

The paste clarity of tef starches is opaque and is almost the same as normal maize starch. The gel texture is short and smooth. The *in vitro* mode of porcine pancreatic α–amylase attack of native tef starch is by surface erosion and is different from the way maize starch is attacked (pitting) but as with maize is endocorrosion in nature. Native tef starch hydrolysis with mild HCl acid is a gradual surface degradation, leading to deformation and fragmentation with no craters formed, unlike in native maize starch. During the earlier stages, native tef starch appeares to be slightly better substrate for α–amylase digestion and mild HCl acid hydrolysis than native maize starch, presumably in part because of the more amorphous nature of tef starch than maize starch.

Since tef starch granules are very small and smooth they are expected to offer the same starch functionalities (application as fat mimetics, as cosmetics dusting powder, pharmaceutical carrying agents, flavour and aroma carriers) as other small granule size starches like rice, amaranthus and quinoa. Since tef starch breakdown viscosity is small, this suggests that it is more suitable for use where starch breakdown due to shearing is a problem. The low retrogradation, cold paste and setback viscosities of tef starch suggest that it is more suitable than maize and wheat starches in baked food applications where starch staling is a problem, and in e.g. refrigerated and frozen food products. Based on the physico–chemical properties of tef starch, application research in food and other industries where the use of tef starch looks promising is required. In the future, characterisation of ultrastructure and molecular size of tef starch macromolecules (amylopectin and amylose) is important to generate more information on the link between starch structure, composition and functionality. Work towards appropriate technology for large scale tef starch extraction is also important.