ABSTRACT

Elephant foot yam (EFY) is an underutilized tropical tuber crop and high source of starch. Starch extracted from EFY is easily susceptible to enzymatic hydrolysis and becomes harmful for diabetes and obese patients. To address this issue, heat moisture treatment (HMT) using various heating sources i.e., hot air oven (HAO), autoclave (AL), and microwave (MW) were employed to modify elephant foot yam starch (EFYS). Response surface methodology was used to determine the optimum treatment conditions of time for HAO (3-9 h), MW (60-120 s), AL (10-30 min); temperature for HAO (80-120 °C), AL (110-130 °C); microwave power (400-600 W); and moisture content (15-35 %) for all modification processes. Rapidly digestible starch (RDS), slowly digestible starch (SDS), and resistant starch (RS) were the responses for the optimization process with a goal of maximizing RS and SDS fractions and minimizing RDS fractions. The optimized process conditions were found for all the modification processes and further detailed characterizations were carried out. HMT modification was successful in increasing RS and SDS fractions, while lowering the RDS fractions in EFYS and HMT using HAO treatment showed the highest alterations. Surface cracks, pitting, and scratching were prominent on the granules after modification, leading to an increase in surface roughness. HAO treated EFYS exhibited the highest formation of agglomerations and an increase in particle size compared to other treatments. All the modified EFYS samples had a significant increase in amylose content, and the highest was observed in HAO treatment. An increase in gelatinization temperature and reduction in gelatinization enthalpy were observed in HMT EFYS. Relative crystallinity was reduced in HMT modified EFYS which varied in the range of 35–41% as compared to native EFYS of 43%. A decrease in molecular weight from native 6.39×10^7 g/mol to HMT modified EFYS was observed which varied in the range $4.51–5.37 \times 10^7$ g/mol. Interestingly, the increase in elastic behavior was noticed in all modified EFYS compared to native EFYS and the highest increment was noted in HAO treated EFYS, suggesting the formation of a strong gel network under high shear. Various enzyme kinetic models were employed to study the digestion kinetics of native and modified EFYS and among those first order kinetic model showed the best fit for the experimental data of the starch digestogram. A maximum drop in peak viscosity was detected in the HAO modified EFYS that confirms its thermostability when compared to the native and other treated starches. All the starch pastes exhibited shear-thinning behavior, however, isothermal heating of starch paste at 95°C revealed rise in apparent viscosity after gelatinization with increasing shear rate in all HMT modified EFYS. Relative crystallinity was decreased significantly in native EFYS while cooking at 86, 91, and 100 °C for 2, 6, and 10 mins. However, Native-86-10, Native-91-6 min, and Native-100-10 min EFYS showed amorphous state, whereas, at the similar conditions HAO-86-10 min, and HAO-91-10 min showed relative crystallinity of 24% and 19%, respectively.

Keywords: Elephant foot yam starch, heat moisture treatment, resistant starch, optimization, starch digestogram, crystallinity.