# Abstract

This thesis aims to investigate the quality of flours and starches from the underutilized yam cultivars of Assam. The physicochemical, functional, and pasting properties of flours and starch from cultivated *Dioscorea* species of northeast India are not been thoroughly studied or are not available. At the same time, no study compares the effect of hydrothermal treatments such as HMT and ANN treatments on yam starch and the effect of moisture levels during those treatments on yam starch. Likewise, study on hydroxypropylated and cross-linked yam starch is very few but not available on the species or cultivars investigated in this study, resulting in limited utilization of yam starch in the industries. Therefore, this study was designed in which yam flour and almond protein isolate blends were used in the preparation of gluten-free cookies, and a quality assessment of the prepared cookies was done. In addition, the effect of physical and chemical modifications on the functional, thermal, pasting, crystalline, morphological, and rheological properties of underutilized yam starches was investigated, and the suitability of native as well as hydrothermally treated starches for developing edible films was analyzed.

The current research carried out in this study was segregated into five major objectives to explore the potential of the underutilized yam species. For the first objective, the characterization of flours obtained from three yam species, viz. *Dioscorea esculenta* , *Dioscorea alata* (purple yam), and *Dioscorea alata* (yellow yam) were done, and the obtained flours were enriched with 10 % of almond protein isolate for the preparation of cookies (Chapter 4A). The yam flours were blended with almond protein isolate (API) in an attempt to get the qualities of gluten in gluten-free food. The protein content of the yam flours increased in the range from 13.46 – 16.12 % due to the mixing of API in the flours. Foaming capacity increased the range from 3.55 – 512 % to 11.51 - 14.93 % after blending of yam flours and API. The foam stability of the yam flours was found to be decreasing from the range of 52.42 – 68.44 % to 21.61 – 34.63 % after blending of yam flours and API. WAC and OAC of the yam flours increased after mixing with API. A RVA test of the yam flour-API blends showed a decreasing peak viscosity, hot paste viscosity, final viscosity, breakdown, and setback with an increasing pasting temperature, compared to the native flours. The ratio of 1047/1022 $cm^{-1}$ and

995/1022 $cm^{-1}$ obtained from FTIR spectra was found to be higher for the yam flour-API blends, compared to the native flours. In the rheological frequency sweep test, the value of tanδ was the highest for *D. esculenta* flour-API blends compared to all other flours. No significant difference ($p<0.5$) in the cookie hardness value of cookies from *D. esculenta* flour-API blends (3.01 ± 0.28 kg) and wheat flour cookies (3.64 ± 0.37 kg). Sensory analysis revealed a higher preference for cookies from *D. esculenta* flour-API blends, while the cookies from *D. alata* flour-API blends were the least preferred due to the bitter taste in the cookies. The results of the work in this objective indicated the suitability of *D. esculenta* flour-API blends for baked goods and the requirement of further research for the improvement of the quality of flours from yam species like *D. alata*.

The second and third objectives were to isolate the starch from the yam species and physically modify the isolated starch, respectively (Chapter 4B). Starches from three yam species, viz. *D. esculenta* , *D. alata* (purple yam), and *D. alata* (yellow yam) were isolated and subjected to heat moisture treatment (HMT) with 20 and 30% moisture at 110 ºC for 3 h and annealing (ANN) at 1:2 and 1:4 starch to water ratio and 50 ºC for 24 h, and their effect on functional, thermal, pasting, morphological, and rheological properties, and *in vitro* digestibility was investigated. Amylose content of native and hydrothermally modified starches of *D. esculenta* (Y1), *D. alata* (purple yam, Y2), and *D. alata* (yellow yam, Y3) ranged from 21.34 to 29.53 %, 26.58 to 33.93 %, and 32.71 to 38.17 %, respectively. Y3 and Y2 starches showed a high amylose leaching behavior due to the total amylose content of the starches. A reduction in the intensities of the peak at 1000 $cm^{-1}$ was revealed from FTIR spectra in HMT and ANN starches indicating the breakdown of C-H bonding. From DSC, a significant decrease and increase in the ΔH of starch after HMT and ANN, respectively, were found compared to their respective native starches and with moisture levels. After ANN, the setback viscosity (SB) increased steadily, whereas a decrease in SB was observed after HMT, compared to the native starch. The final viscosity was found to be higher for ANN starches and lower for HMT starches as compared to the native starch granules. ANN-treated starches showed a significantly ($p<0.5$) higher value of shear stress than the native starches during the steady shear test, indicating stronger molecular interactions among starch granules in the pastes. The dynamic rheological test showed lower tan δ values of the native and modified starches of Y2 and Y3 than the tanδ values (0.30-0.53) of the native and modified starches of Y1, respectively. An increase in slowly digestible and resistant starch with a decrease in rapidly digestible starch was noticed after HMT and ANN modifications.

In the fourth objective, chemical modification of isolated starches from *D. esculenta* (Y1), *D. alata* (purple yam, Y2), and *D. alata* (yellow yam, Y3) was done (Chapter 4C). SEM micrographs showed the presence of some small attachments around the starch granules, indents on the surface of the granules, and agglomeration of starch granules in hydroxypropylated starches, while, starch granules appeared to be rougher and had dents in the surface in case of STMP modified starches. Hydroxypropylated Y3 starches showed the highest paste clarity (55.43 ± 0.10) and lowest freeze-thaw stability (18.31 to 20.87 %) during the first to third freeze-thaw cycle (FTC) than all the other starches, respectively. The magnitudes of consistency coefficient ($k$) of the cross-linked starch pastes values were found to be much higher and $n$ (flow behavior index) was found to be lower than those of the native starch pastes, indicating a high structural strength of the pastes. The moduli (G´ and G´´) were found to be higher for cross-linked starches and lower for hydroxypropylated starches compared to the native starches.

The final objective deals with the development and characterization and starch-based edible films with and without walnut oil (WO). The film-forming solutions were also applied as coatings to grapes and the quality assessment of the grapes was done during the storage period (Chapter 4D). A significant decrease ($p<0.5$) in the swelling index and solubility was observed for the hydrothermally treated and native starch films with WO compared to the native starch film without WO, which can be linked to crystallinity % as evident from the XRD analysis of the films. HMT starch films with WO showed a high surface roughness in the SEM micrographs, indicating the heterogeneity of the surface of the films. A new bandwidth with a peak at 1745 $cm^{-1}$ was observed in the walnut oil incorporated film possibly due to the presence of saturated aldehyde functional groups. ANN films with WO had the highest crystallinity in the range of 47.41 – 47.72 %, as per the XRD analysis. The lowest water vapor permeability (WVP) of 1.64 – 2.11 $10^{-6}$ g $day^{-1}$ $m^{-1}$ $Pa^{-1}$ was observed for the ANN films with WO. Both the ANN and HMT starch coatings with WO, when applied as coatings on grapes, delayed the reduction of weight, TSS, titratable acidity, total phenolic content, and antioxidant activity, and the development of anthocyanins during storage for 15 days.

The results demonstrated that edible coatings prepared from ANN-modified starch with WO can significantly enhance the shelf life of grapes, and can be tested on other food items.