Abstract

This project aimed to develop longan product by transforming sugars in longan syrup made from overproduced longan to another type of sugars called fructooligosaccharide through enzymatic means and optimizing conditions for extracting bioactive compounds from post extraction waste. Fructooligosaccharide (FOS) made from longan syrup was then evaluated for toxicity towards various systems of the tested animal body. The analyses on the return of investment from the production and potential of FOS in the commercial scale were also carried out.

The results of longan syrup production from mixed B and C grade longan revealed longan syrup contained sucrose, glucose and fructose at the concentration levels of 200.86±2.50, 211.65±2.5 and 185.87±2.65 g/l, respectively. Furthermore, 1-kestose which was another type of fructooligosaccharide was also detected at 8.07±0.11 g/l. The analysis of bioactive compounds such as gallic acid, corilagin and ellagic acid in longan syrup with HPLC revealed the bioactive compounds content of 0.40±0.02, 0.05±0.01 and 0.03±0.01 mg/g, respectively. The longan syrup was subsequently synthesized to FOS using Pectinex Ultra SP-L enzyme with Central Composite Design (CCD) by varying enzyme volumes (10-60 ml) and reaction times (10-24 h). The results from CCD indicated the optimal conditions for FOS production were Pectinex Ultra SP-L volume of 20.12 ml/1 l of longan syrup and reaction time of 24 h. The produced FOS mixture contained sucrose, glucose and fructose concentration levels of 20.13±0.25, 229.80±1.22, and 156.40±3.34 g/l, respectively. These were compared with other types of fructooligosaccharide sugars, namely, 1^{F}-fructofuranosylnystose, nystose and kestose at 1.15±0.14, 10.08±0.18 and 55.87±2.24 g/l, respectively. The bioactive compounds content were gallic acid, corilagin and ellagic acid at 0.37±0.02,

0.05±0.00 and 0.04±0.00 mg/g, respectively. The final FOS produced from the optimal condition was then mixed with maltodextrin and silicon dioxide at the levels of 35.5 and 1.3 % (w/w), respectively, and dried in a vacuum oven to produce FOS powder. Sucrose, glucose, fructose, nystose and 1-kestose were found in the powder with corresponding concentration levels of 13.18±1.39, 170.61±0.35, 101.47±0.31, 1.75±0.24 and 7.37±0.66 mg/g, respectively, with bioactive compounds component including gallic acid, corilagin and ellagic acid at 0.32±0.02, 0.05±0.00 and 0.04±0.00 mg/g, respectively.

The extraction of bioactive compounds from dried longan waste by varying the concentration levels of ethanol, extraction times and extraction temperature levels were done using a temperature control shaking incubator with the set speed of 200 rpm. The optimal conditions for extracting the bioactive compounds were obtained using the mixture of ethanol with water at 50:50 ratio for 15 h at 60°C. The obtained yields of gallic acid, corilagin and ellagic acid in dried longan waste were 0.38±0.00, 0.64±0.01 and 2.42±0.19 mg/g dry weight, respectively. The subsequent evaporative concentration under vacuum condition yielded the final product in powder form. The powder of dried longan waste had contents of gallic acid, corilagin and ellagic acid of 1.70±0.14, 1.04±0.04 and 5.33±1.50 mg/g dry weight, respectively. These results suggested that FOS produced from mixed grade longan not only had the distinctive properties from normal sugars but also had the bioactive compounds which could satisfactorily inhibited free radicals. Moreover, the remnant by-products of longan syrup production could be extracted further to yield the bioactive compounds in powder form with similar level of free radicals inhibition.

In the present study, the acute and subchronic oral toxicity studies of FOS from longan in rats were performed in order to evaluate its safety. In acute toxicity study in female rats, an oral dose of 5,000 mg/kg of FOS did not produce mortality or any toxic signs or any pathological abnormalities of internal organs when necropsy was done on day 14. In the subchronic oral toxicity study, FOS at the doses of 500, 1,000 and 3,000 mg/kg/day for 90 days did not cause death or any changes of the general behavior of both sexes of rats when compared to the control groups, which received distilled water. Some average hematological and biochemical values as well as some internal organ weights of FOS-treated groups showed statistically significant difference when compared to those of the control groups. However, all of these values were within the normal ranges of the normal rats and were considered as biological variations. Moreover, no abnormality of internal organs was observed in both gross and histopathological examination. These results demonstrated that FOS was fairly safe in rats and its no-observed-adverse-effect level (NOAEL) was found to be 500 - 3,000 mg/kg/day.

In the part of economic study from the cost analysis, the study not only studies the initial cost but also the operation cost , maintenance of 5% of the investment and the interest rate is 12%. The results showed that the cost of the project is worth to produce. The net present value (NPV) of producing FOS and FOS powder are 99,265,710 and 86.262,066 baht, respectively. The payback period (PBP) in greatly return in the first year of both projects mentioned above. Later on, the marketing research showed that there were 500 samplers in the Northern provinces. The study also found that if longan syrup was to be introduced to the market, it should go through an intensive marketing strategy. The data were provided by the FOS product

tasting fruit syrup. The highlight of the product is predominantly in the scent of fruits, and the intense flavor. The respondents with the product are at a moderate level. If the new product is released, it should be improved as follows: color and taste, certification of institutions or professionals, a mix of various desserts or sweets and capital investment support from government.

The specification of longan syrup and synthesized FOS included initial total sugars concentration level in the range of 545.80-667.08 g/l with initial sucrose concentration level between 180.77-220.95 g/l. The FOS synthesized from longan syrup contained sugar called fructooligosaccharides in the range of 60.39-73.81 g/l (equivalent to 30% of initial sucrose concentration level). FOS also contained several bioactive compounds, namely, gallic acid, corilagin and ellagic acid in specific ranges of 0.33-0.41, 0.04-0.06 and 0.03-0.05 mg/g, respectively. The overall bioactive compounds content of FOS was in the range of 0.40-0.50 mg/g from initial overall bioactive compounds content in longan syrup of 0.43-0.53 mg/g (0.36-0.44 mg/g of gallic acid, 0.04-0.06 mg/g of corilagin and 0.02-0.03 mg/g of ellagic acid). The amount of microbes in FOS newly synthesized from longan syrup was 5.7 cfu/g and then increased to 110 cfu/g after keeping for 6 months at room temperature.

Keywords: fructo-oligosaccharide, longan syrup, enzyme, longan, antioxidant activity, toxicity, return of investment analysis, commercial potential