PHYSICOCHEMICAL PROPERTIES AND IN VITRO STARCH DIGESTIBILITY OF THAI TRADITIONAL RICE CAKE AND PEA CAKE

R. Dhimas S. Utomo1, Yadi Haryadi1, Eko Hari Purnomo1, and Rungarun Sasanatayart2

1Department of Food Science and Technology, Faculty of Agricultural Engineering Technology, Bogor Agricultural University, IPB Darmaga Campus, PO. Box 220, Bogor, West Java, Indonesia
2School of Agro-Industry, Mae Fah Luang University, Muang, Chiang Rai 57100, Thailand

ABSTRACT

Physicochemical properties and in vitro starch digestibility of Thai traditional rice cake (kao ram phune) and pea cake were observed. Samples were prepared from flour slurries with 20% total solid, cooked at 95 °C for 25 min and cold set at room temperature for 6 hours to facilitate gel forming. Proximate analysis, amylose content, thermal properties, pasting properties and granular morphology of flours were determined and related to the textural properties and resistant starch content of the corresponding cake. Results showed that pea flour had higher protein (21.84 %db) and lipid content (0.80 %db) compared to those of rice flour and sticky rice flour which were 7.21 %db and 0.41 %db; 6.12 %db and 0.29 %db, respectively. Rice flour was mixed with sticky rice flour (in ratio of 100:0, 97.5:2.5, 95:5, 92.5:7.5, 90:10) to vary the amylose content (from 31.07 %db to 27.48 %db). Sticky rice flour was the lowest in amylose content (4.22 %db) whereas pea and rice flour 16.01 %db, 31.07 %db respectively. Conversely, pea cake was the highest in the amount of the resistant starch (9.62 % total starch), whereas cakes through ratios the values were (0.52 %, 0.45 %, 0.40 %, 0.34 %, respectively). Obtained cakes (pea cake, rice cake 100:0, rice cake 90:10) were cold set for 6 hours at room temperature, 6 hours at 4 °C, and 24 hours at 4 °C. Results showed that cold set increased hardness; 267.94 g - 521.71 g - 851.16 g (pea cake), 152.89 g - 197.78 g - 269.35 g (rice cake 100:0), and 69.73 g - 78.63 g - 121.90 g (rice cake 90:10). Resistant starch significantly increased after cold setting; 0.54 % - 0.73 % - 0.95 % (rice cake 100:0), 0.34 % - 0.45 % - 0.56 % (rice cake 90:10). However pea cake exhibited opposite trend as the RS content decreased during cold setting; 9.62 % - 7.46 % - 6.92 %. There was no clear trend for the color properties resulted from variation in amylose content and cold setting conditions.

Keywords: physicochemical properties, in vitro starch digestibility, pea cake, rice cake
SUMMARY

This research was first aimed to investigate the effect of flour types (pea flour, rice flour, sticky rice flour) and mixed flour (rice flour and sticky rice flour) on physicochemical properties and starch digestibility of the corresponding pea cake and rice cake. Second, to investigate the effect of cold setting conditions on physicochemical properties and starch digestibility of pea cake and rice cake.

In the preliminary research, chemical composition of raw materials involved moisture, ash, protein, crude fat, and amylose content were determined as well as granular morphology, thermal and pasting properties. Experiment I was conducted in order to investigate the effect of mixing rice flour and sticky rice flour on granular morphology, thermal, and pasting properties. The resulted cakes were then analyzed in term of starch digestibility, textural and color properties (experiment II). At last, effect of cold setting condition on starch digestibility, textural, and color properties of pea cake and rice cake was investigated.

Results showed that pea flour, rice flour, and sticky rice flour were different significantly. Pea flour exhibited typically oval starch granules with average size of 11-44 μm, whereas rice flour and sticky rice flour were found to be polygonal shape sized 2.8-14 μm and 4.3-17.1 μm, respectively. Round shape granules were also found in the rice flour which supposed to be cassava. In the chemical composition, the highest ash (2.83 %db), protein (21.84 %db) and lipid content (0.80 %db) were obtained from pea flour. Rice flour possessed apparent amylose content of 31.07 %db, whereas pea flour and sticky rice flour were 16.01 %db and 4.22 %db, respectively. Rice flour and sticky rice flour were mixed at the ratios of 100:0, 97.5:2.5, 95:5, 92.5:7.5, 90:10 to vary the amylose content, and it was revealed that as the portion of sticky rice increased, the amylose content decreased. The ordered values through ratios were 31.07 %db, 29.62 %db, 29.24 %db, 28.12 %db, and 27.48 %db.

Pea flour and sticky rice flour possessed gelatinization temperature range of 69.19-77.11 ºC and 58.54-74.50 ºC, with resulted endothermic enthalpy of 3.29 J/g and 10.43 J/g, respectively. Rice flour behaved differently as two endothermic peaks were exhibited. The first peak corresponded to the melting of cassava starch which appeared at lower temperature (62.40-70.37 ºC) with the endothermic enthalpy of 1.56 J/g. The second peak at higher temperature (72.45-81.10 ºC) with the endothermic enthalpy of 3.94 J/g corresponded to that of rice flour. Addition of sticky rice flour to the rice flour did not affect thermal properties significantly.

In term of pasting properties, pea flour, rice flour, and sticky rice flour exhibited their typical RVA curve. The highest peak viscosity (388.5 RVU) and breakdown viscosity (185.9 RVU) were obtained from sticky rice flour, whereas final viscosity (254.3 RVU) and setback viscosity (213.1 RVU) were owned by rice flour. There were no significant effects by adding sticky rice flour to the rice flour through all ratios.

The main textural properties (hardness and adhesiveness) of pea cake and rice cake were analyzed, both commercial and experimental one. Hardness and adhesiveness values of pea cake resulted from experiment were 267.94 g and -48.76 g.s, whereas commercial pea cake were 260.16 g and -66.39 g.s, respectively. Rice cake possesed hardness and adhesiveness values of 152.89 g and -
53.85 g.s (experiment), 158.39 g and -42.81 g.s (commercial rice cake). Through ratios, hardness score was found to have positive correlation with apparent amylose content ($R^2 = 0.895$). Conversely, adhesiveness exhibited negative correlation with apparent amylose content ($R^2 = 0.899$).

Pea cake and rice cake were also different in the color properties. Pea cake was higher in $L^*$ value (64.41) and $b^*$ value (13.57) compared with that of rice cake (57.42; 2.68, respectively). Inversely, rice cake was higher in $a^*$ value (-2.98) than pea cake (-1.33). Through ratios, rice cake behaved disorderly in term of $L^*$, $a^*$, $b^*$ values.

Investigation on in vitro starch digestibility revealed that pea cake contained markedly higher amount of resistant starch (9.62 % total starch) compared with that of rice cake (0.54 % total starch). As the portion of added sticky rice flour increased, resistant starch content increased. The ordered values were 0.52 %, 0.45 %, 0.40 %, 0.34 %, respectively. However, only the extreme addition of sticky rice flour (ratio of 90:10) was statistically significant.

In the second experiment, cold setting conditions (6h, room temperature; 6h, 4 °C; 24h, 4°C) were conducted in which starch digestibility, textural, and color properties were influenced by. Hardness increased during cold setting. The increment in hardness values were; 267.94 g, 521.71 g, 851.16 g (for pea cake); 152.9.25 g, 197.78 g, 269.35 g (for rice cake 100:0); and 69.73 g.s, 78.63 g.s, 121.90 g.s (for rice cake 90:10). Adhesiveness increased as well as hardness with the values of; -48.76 g.s, -79.43 g.s, -96.68 g.s (for pea cake); -53.85 g.s, -82.92 g.s, -100.30 (for rice cake); and -85.83 g.s, -90.09 g.s, -114.20 g.s for (rice cake with 10 % sticky rice flour added). Longer storage (24 hours) in low temperature (4 °C) lowered the lightness of all samples that was mainly due to retrogradation. However, there was no exact trend for the $a^*$ and $b^*$ values through samples upon cold settings.

Starch digestibility was found to be influenced by cold setting conditions. The increments of resistant starch content were 0.54 % to 0.73 %, and finally 0.95 % for rice cake (100:0), whereas 0.34 % to 0.45 %, and finally 0.56 % for rice cake with 10 % sticky rice flour added (90:10). Pea cake behaved differently as the resistant starch amount in the cake decreased from 9.62 % to 7.46 %, and finally 6.92 % through cold setting conditions.