Potential of fruit and vegetables residues in functionalization of confectionery products and minimization of glycemic response

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Introduction Apple and beetroot pomace flour (APF and BPF), obtained from minimally processed pomace using recently disclosed technological procedure, were evaluated as a source of biomolecules with antioxidant, antidiabetic and antiobesity effects, such as dietary fiber (DF) and polyphenolics (DP). Here, APF and BPF were employed to obtain healthy alternative to jelly candies burdened with energy aiming to meet the recommendations for DF intake and glucose spike minimization.

Jelly candies with incorporated APF and BPF

Methodology An experimental setup was conducted utilizing pectin, gelatin and agar as gelling agents, 2 sweeteners (sucrose or combination of erithritol, stevia, fructose and inulin) and three levels of enrichment (APF, BPF and no flour). Pectin based jelly candies with sucrose (P-APF, P-PBF and control P) and sucrose alternatives (P*-APF, P*-PBF and control P*) were subjected to determination of proximate composition and DF (insoluble and soluble), as well as total polyphenolic content (TPC) and AO activity (DPPH and FRAP) upon *in vitro* digestion (INFOGEST). Results were compared to agar and gelatin based candies. Also, *in vivo* determination of postprandial glucose response upon consumption of 25 g of pectin candies was conducted. The incremental area under the curve (IAUC) for capillary blood glucose concentration over 120 min was calculated. Glycemic index and load (GI and GL) were determined for P-APF, P-BPF, P*-APF and P*-PBF according to the standard procedure.

Results

Fiber content was above 3 g/100 g in P-APF and P-PBF enabling claim "fiber source" to be reached, while in P*-APF and P*-PBF exceeded by far requirement to claim "high in fiber" (at least 6 g /100 g). Such high fiber content can significantly contribute recommended intake of 14 g DF per each 1,000 kilocalories (4,184 kJ). Carb to fiber, as well as sugar to fiber ratio were calculated as indicators of functionalization by APF and BPF addition and sucrose replacement (**Fig 1**).

Content of TPC and AO activity in all jelly candies was prominent. The Relative Antioxidant Capacity Index (RACI) calculated by assigning equal weight to FC, DPPH and FRAP was applied as an indicator of functionalization in terms of increased AO activity. As a relative index, RACI provided an accurate ranking of the AO activity of 18 formulations (six controls, three with, and three without sucrose, and formulations enriched with APF and BPF, six with, and six without sucrose). An insight into the effects of flour addition and sucrose substitution was achieved (**Fig 2**).

Based on IAUC for 6 pectin samples, both the addition of APF and BPF and sucrose replacement was associated with improved glucose tolerance. The difference in IAUC for P and P* (137 and 55 mM×min) showed that sucrose substitution resulted in 60% reduction, similar as flour incorporation. The incorporation resulted in IAUC decrease to 61 and 55 (P-APF and P-BPF) and 24 and 22 mM×min (P*-APF and P*-BPF). In comparison to P and P*, the reduction was 55-60%. P*-APF and P*-BPF had 82 and 84 % lower IAUC than P. GI of P-APF and P-BPF was bellow 50. GI of P*-APF and P*-BPF was below 30 (**Fig 3**). Low GL indicated a significantly higher intake allowance compared to commercial versions.

Fig 1. Effect of APF and BPF introduction into pectin (P), agar (A) and gelatin (G) matrix with sucrose (A) and its subsequent replacement with low-energy sweeteners (B) (marked with *) on carb:fiber and sugar:fiber ratio.

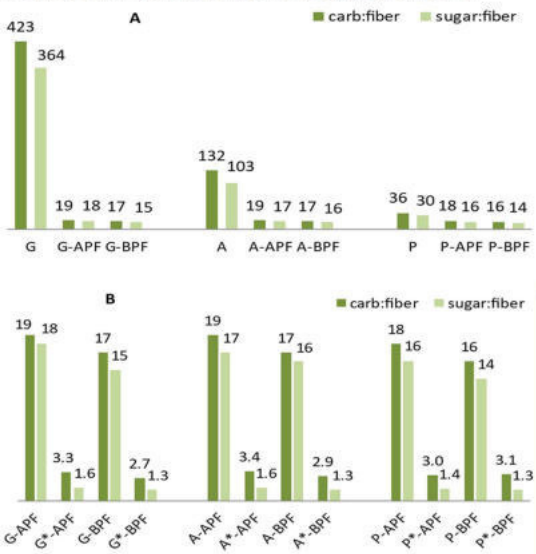


Fig 2. RACI for agar (A), pectin (P) and gelatin (G) based jelly candies with APF and BPF, sweetened with sucrose and sucrose alternatives (marked with *), in comparison with respective controls.

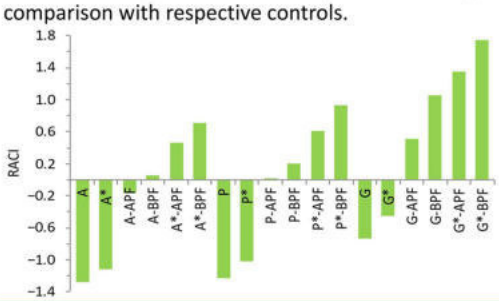
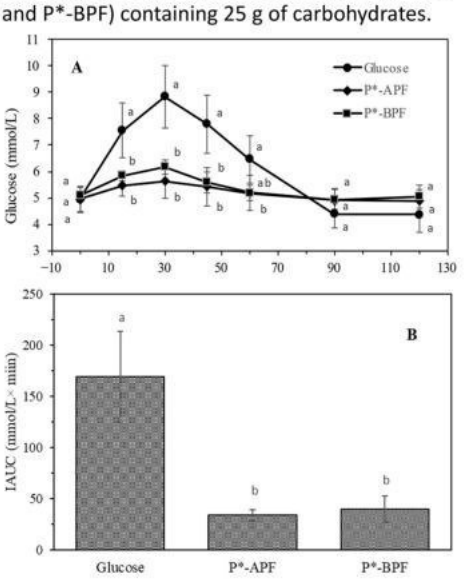


Fig 3. OGTT curve (A) and IAUC (B) after consumption of 25 g of glucose or candies with APF and BPF and sucrose substitutes (P*-APF and P*-BPF) containing 25 g of carbohydrates.



Conclusion

Efficiency of applied approach in functionalization of confectionery burden with calories and minimization of glucose spike represent an example of agro-residues re-introduction into a diet with the highest potential contribution to anti-obesity strategy. Results obtained show that health promoting properties of agro-residues can be available to all consumers, including those who avoid sucrose for any reason.

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