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Development of duckweed powder incorporated cookie and evaluation of its physicochemical, nutritional, functional, microbial and sensory properties

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Duckweed, a free-floating aquatic plant from the family *Lemnaceae*, is an underutilized nutritional resource with high protein content, providing all essential amino acids. In contrast, wheat flour, the primary structural component of most bakery products, has relatively low protein and micronutrient content. This study aimed to develop cookies incorporating duckweed powder and evaluate their sensory properties, while comparing the physicochemical, nutritional, functional, and microbial properties with the control cookie. Duckweed powder was prepared using a 1:1 ratio of *Spirodela polyrhiza* and *Lemna perpusilla*, which was selected based on preliminary trials. The physicochemical, nutritional, and functional properties of the duckweed powder were determined. Based on preliminary trials optimizing sensory acceptability and quality, four cookie formulations with 10, 20, 30 and 40% duckweed powder substitution were developed, along with the control cookie made of 100% wheat flour. A sensory evaluation conducted with 40 untrained panelists using a nine-point hedonic scale, identified 10% duckweed incorporation as the optimal for appearance, color, aroma, flavor, texture, and overall acceptability. The proximate analysis of the optimized cookie showed differences (P<0.05) compared to the control, with 5.05±0.03% moisture, 12.25±0.02% crude protein, 3.76±0.04% crude ash, 21.45±0.03% crude fat, 10.25±0.03% crude fiber, and 47.23±0.10% digestible carbohydrates. The duckweed incorporated cookies provided 430.98±0.05 kcal per 100 g, 22.43±0.04% sugar, 0.74±0.02% salt, and 1.64±0.03% total dietary fiber. The mineral content (Mg, K, Ca, Na, Fe, Mn, Cr, B) was also enhanced (P<0.05). Functional properties were improved, with higher total phenolic content (1.62±0.03 mg GAE/g), flavonoid content (282.05±0.01 mg CAT/g), 2,2-Diphenyl-1-picrylhydrazyl radical scavenging activity (212.36±1.20 mM TE/g), and α-Amylase inhibition (IC_{50} 2.26±0.02) compared to the control (P<0.05). Microbial analysis confirmed that total plate count, yeast and mold remained below standard limits for one month. All chemical, microbial, and heavy metal contents complied with Sri Lanka Standards Institution requirements. The findings suggest that duckweed powder holds significant potential as a partial substitute for wheat flour, offering enhanced nutritional and functional benefits in cookie formulations.

Keywords: Cookies; duckweed; micronutrients; protein

Underlined is the presenting author.