Abstract

The food processing industry generates large quantities of by-products such as fruit peels, bran, and seed residue, which end up being wasted without realizing their nutritional content. This study aimed to optimize fiber-enriched 3D-printed cookies with mango peel, rice bran, and hemp seed milk residue as sustainable food production and waste reduction inputs. 5% fiber formulations were developed utilizing extreme vertices mixture design in Minitab. Such cookies were also 3D-printed and subjected to comprehensive physicochemical (color, spread ratio, texture, moisture, fiber content) and sensorial analysis, as well as comparison with conventionally molded cookies and assessment by the Food Technology Neophobia Scale (FTNS). Results gave valuable insight into ingredient functionality: enzymatically treated rice bran increased spread and softness, while hemp seed residue increased hardness and fracturability with its protein and insoluble fiber. Cookies printed using 3D exhibited reduced spread but increased hardness and fracturability by controlled deposition and organized layers. Sensory testing indicated higher acceptance of cookies printed with 3D owing to improved appearance, crunchiness, and flavor. FTNS analysis indicated that there was a significant negative relationship between liking and consumer neophobia, with higher neophobia strongly relating to lower acceptance for all sensory characteristics. Findings support the ability of sustainable integration of by-products and 3D printing in the formulation of functional, acceptable foods for consumers but emphasize that psychological factors like food technology neophobia will have to be overcome in the future for market acceptability.

Keywords: 3D food printing, food waste, FTNS, hemp seed, mango peel, mixture design, rice bran