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DEVELOPMENT OF FUNCTIONAL WAFFLE CONES ENRICHED WITH FIBRES,
POLYPHENOLS, AND CAROTENOIDS DERIVED FROM ROSEHIP WASTE POWDER

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Abstract: The powder obtained from rosehip waste remaining after purée production represents a valuable source of bioactive compounds. This study evaluated the potential of rosehip waste powder (Rp) as a functional ingredient in waffle cone formulations, replacing 10–20% of wheat flour. The addition of Rp improved the fibre, polyphenol, and carotenoid content without significantly altering texture or sensory properties, while maintaining high consumer acceptability (92–93%). Therefore, Rp can be effectively used to enrich waffle cones within a circular economy approach.

Introduction

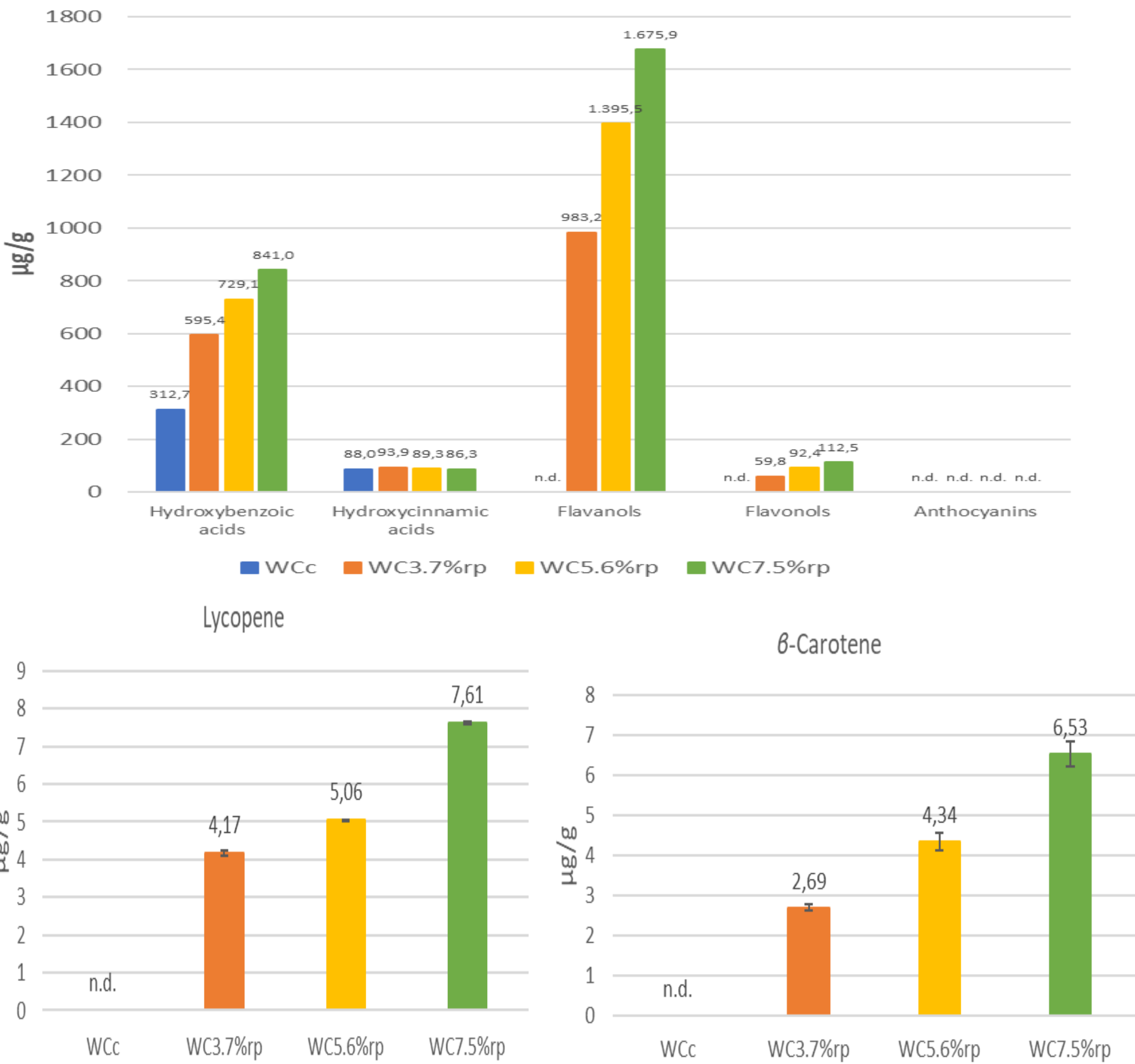
The waste that remains after processing the rosehips to obtain rosehip purée (raw material for rosehip jam) can be a valuable source of fibres, carotenoid pigments, phenolic compounds, and micro- and macro-elements (Borša (Bogdan) et al., 2024). Therefore, it could be recovered as a powder (Rp) for later use as an ingredient in the food industry. Aims: The aim of this study was to use such a powder in the formulation of waffle cones by partially replacing (10, 15, and 20%, respectively) the wheat flour in a consecrated manufacturing recipe that uses a minimum amount of sugar necessary to obtain this product.

Material and method

Four waffle cone formulations were developed: a control sample (WCc) and three variants containing 3.7%, 5.6%, and 7.5% rosehip powder (WC3.7%rp, WC5.6%rp, WC7.5%rp). The samples were analysed for proximate composition, pH, colour, techno-functional properties (water- and oil-holding capacity, swelling, solubility), texture, and sensory characteristics. The contents of total polyphenols and carotenoids were determined, and production costs were estimated according to the proportion of wheat flour replaced by rosehip powder.

Results and discussions

Content of polyphenolic and carotenoid compounds (µg/g)



Proximate composition, energy value, and pH of rosehip powder, batters, and waffle cones

Parameter/Energy value	Rp	WCc	WC3.7%rp	WC5.6%rp	WC7.5%rp
Moisture (%)	7.13±0.114	1.94±0.023 ^c	2.06±0.026 ^{bc}	2.12±0.064 ^b	2.43±0.007 ^a
Protein (%)	6.98±0.004	14.34±0.499 ^a	10.83±0.509 ^b	10.12±0.003 ^b	9.76±0.0 ^b
Fat (%)	3.31±0.004	4.64±0.005 ^b	5.22±0.164 ^{ab}	5.23±0.191 ^{ab}	5.79±0.249 ^a
Ash (%)	3.31±0.081	0.62±0.039 ^c	0.81±0.017 ^b	0.88±0.018 ^{ab}	0.97±0.014 ^a
Total carbohydrate (%)	79.27±0.242	78.46±0.510 ^b	81.05±0.228 ^a	81.08±0.717 ^a	81.64±0.143 ^a
Crude fibre (%)	37.70±0.042	1.58±0.028 ^c	3.41±0.035 ^b	4.65±0.014 ^a	4.83±0.184 ^a
Energy value (kcal/100 g)	375±0.562	413±0.089 ^a	414±1.141 ^a	415±0.644 ^a	415±1.333 ^a
pH	3.73±0.007	5.57±0.0 ^a	4.90±0.021 ^b	4.79±0.0 ^c	4.73±0.0 ^d
Parameter		Bc	B3.7%rp	B5.6%rp	B7.5%rp
pH		5.70±0.007 ^a	4.56±0.0 ^b	4.42±0.021 ^c	4.35±0.021 ^d

* Data are presented as mean ± standard deviation of three measurements. Different lowercase letters within a row indicate significant differences between batters and waffle cone formulations (p < 0.05, Tukey's test).

Techno-functional properties of rosehip powder and waffle cones.

Parameter	Rp	WCc	WC3.7%rp	WC5.6%rp	WC7.5%rp
WHC (g/g)	1.84±0.056	3.11±0.030 ^a	3.08±0.106 ^a	3.02±0.031 ^a	2.64±0.049 ^b
SC (mL/g)	3.74±0.347	4.98±0.004 ^a	4.48±0.002 ^{ab}	4.23±0.357 ^{ab}	4.23±0.357 ^b
OHC (g/g)	1.07±0.079	0.93±0.031 ^b	0.96±0.031 ^b	1.05±0.021 ^{ab}	1.19±0.062 ^a
Solubility (%)	73.61±0.700	75.33±0.331 ^a	74.15±0.957 ^a	73.93±1.178 ^a	72.65±1.811 ^a

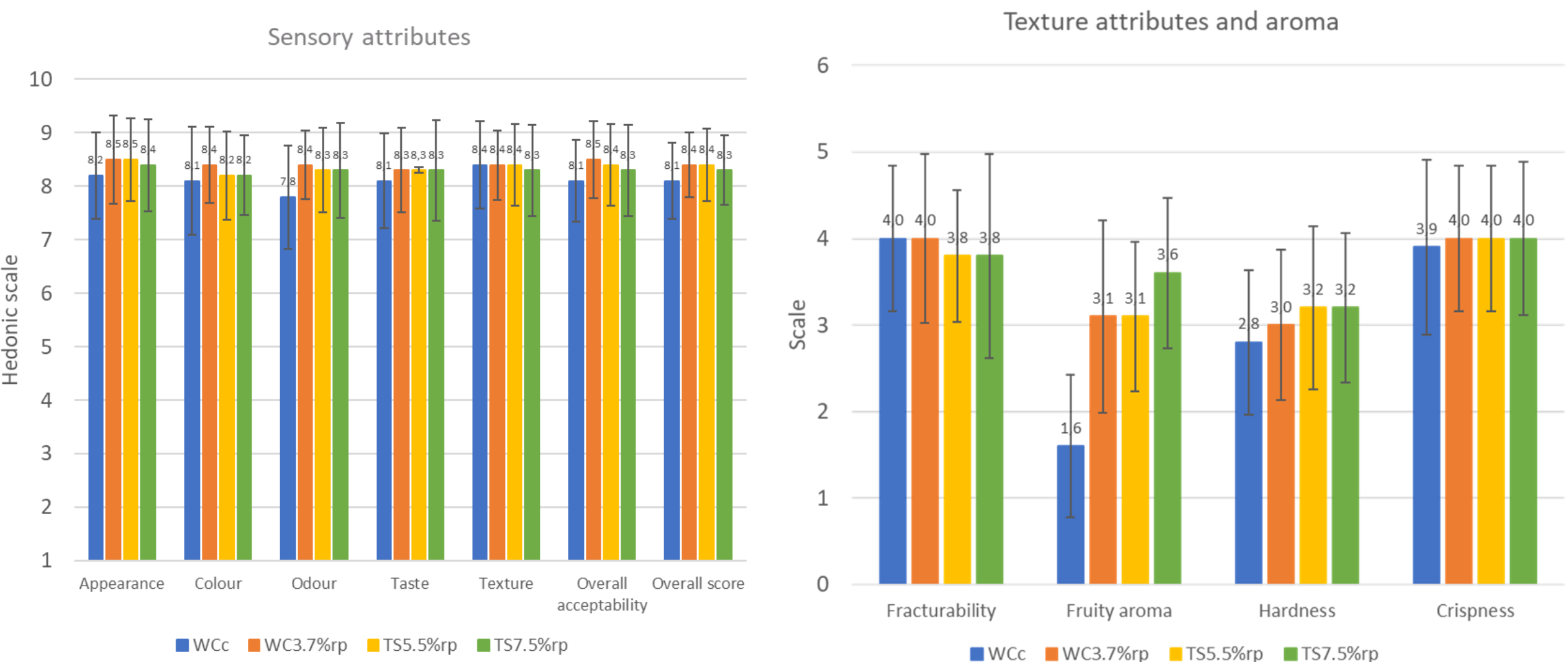


Colour attributes of rosehip powder, batters and waffle cones

Colour attribute	Rp	Batter	B3.7%rp	B5.6%rp	B7.5%rp	Waffle cone	WCc	WC3.7%rp	WC5.6%rp	WC7.5%rp
L*	62.02±0.287	72.85±0.678 ^a	61.68±0.915 ^b	58.57±0.883 ^c	57.64±0.618 ^d	45.78±2.406 ^e	37.15±1.800 ^f	34.84±1.861 ^c	32.93±1.446 ^c	32.93±1.446 ^c
a*	17.75±0.344	2.36±0.145 ^d	9.51±0.275 ^c	10.43±0.367 ^b	12.17±0.281 ^a	13.50±0.875 ^a	13.76±0.889 ^a	13.82±0.419 ^a	14.16±0.778 ^a	14.16±0.778 ^a
b*	31.06±0.695	13.32±0.276 ^d	23.48±0.536 ^c	25.89±0.522 ^b	27.57±0.366 ^a	25.71±0.995 ^a	22.47±1.232 ^b	20.66±1.288 ^c	20.18±1.358 ^c	20.18±1.358 ^c
h*	1.05±0.005	1.40±0.009 ^a	1.19±0.006 ^b	1.19±0.007 ^b	1.16±0.005 ^c	1.08±0.012 ^a	1.01±0.016 ^b	0.99±0.016 ^c	0.97±0.012 ^d	0.97±0.012 ^d
C*	35.77±0.759	13.53±0.286 ^d	25.33±0.585 ^c	27.91±0.606 ^b	30.14±0.433 ^a	29.19±1.020 ^a	26.56±1.397 ^b	24.69±1.508 ^c	24.42±1.597 ^c	24.42±1.597 ^c
ΔE*	-	-	16.75 (obvious)	20.71 (obvious)	23.05 (obvious)	-	WCc 9.48 (large)	WCc 12.26 (obvious)	WCc 14.15 (obvious)	WCc 14.15 (obvious)

Data are presented as mean ± standard deviation of twelve measurements. Different lowercase letters within a row indicate significant differences between batters and waffle cone formulations (p < 0.05, Tukey's test).

Sensory properties of waffle cones and acceptance rate, texture attributes and aroma



AR of 90% for WCc, 93% for WC3.7%rp, 93% for WC5.6%rp, 92% for WC7.5%rp
WCc, control waffle cone; WC3.7%rp, waffle cone formulated with 3.7% rosehip powder; WC5.6%rp, waffle cone formulated with 5.6% rosehip powder; WC7.5%rp, waffle cone formulated with 7.5% rosehip powder

Conclusions

Rosehip waste powder can successfully replace up to 20% of wheat flour in waffle cone recipes, enriching them with fibres and bioactive compounds while maintaining desirable texture and sensory quality. This sustainable reformulation contributes to the valorisation of local by-products and supports circular economy practices in the food industry.

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