Instrumental and sensory properties of cowpea and whey protein concentrate-fortified extruded rice snacks

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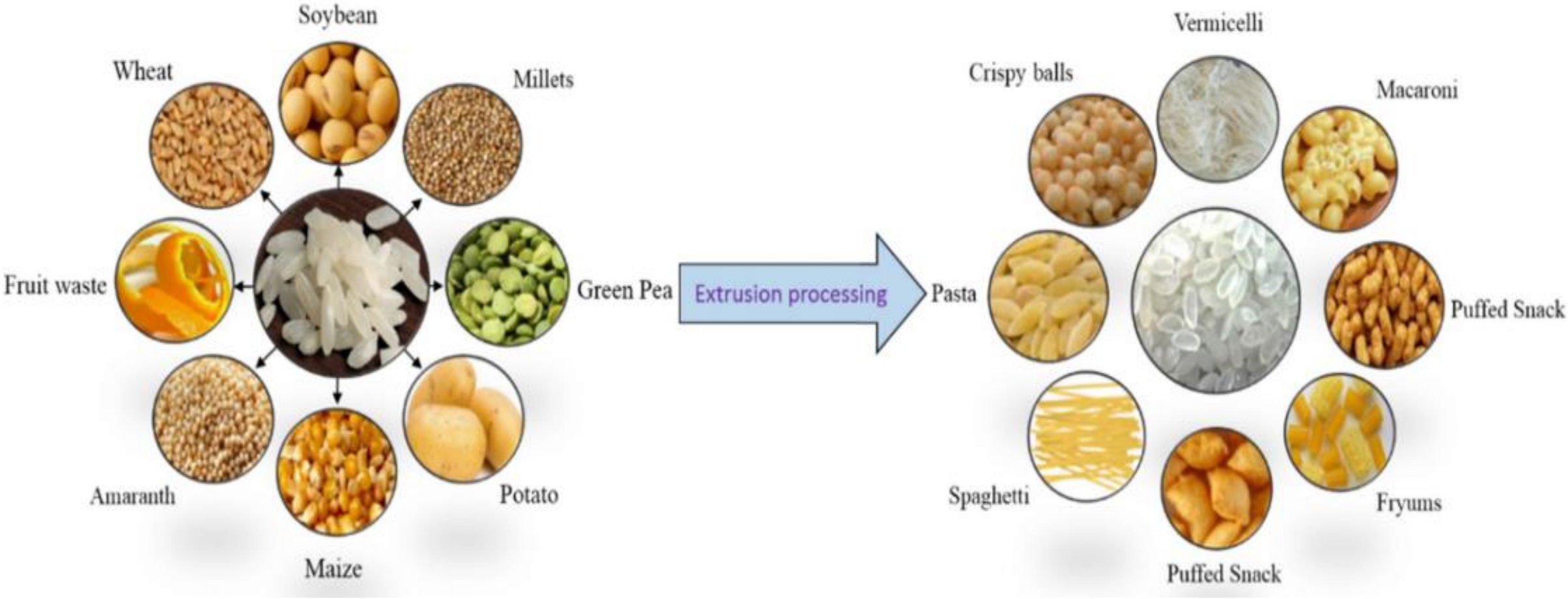
Introduction

- Extrusion technology - offers an excellent avenue to combine different ingredients in ready-to-eat snacks with a wide variety of textures and mouth feelings
- These additions - reduce carbohydrate-rich, high glycaemic products, and improve bioactive components in snacks

Source: masonfit.com/healthy-snacks-guide

Various researchers have strived to enhance the nutritional profiles of extruded products with protein, fibre and bioactive components, through the addition of legumes, fruits, vegetables and food industry by-products



Source:(Dalbhagat, Mahato et al. 2019))

Objective

Assess the instrumental and sensory properties of extruded ready-to-eat snacks rich in fibre and protein using a new combination of ingredients

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Rice

Oryza sativa

Cowpea

Vigna unguiculata L. Walp.

Whey Protein

Methodology

Raw material combinations and extrusion conditions

Extrusion Process Conditions	
Screw speed	252 rpm
Die temperature	111.5°C
Feed rate	7.98 kg h^{-1}
Water rate	90.67 kg h^{-1}
Die diameter	3 mm

100% Rice Flour

90% Rice +
10% Cowpea

80% Rice +
15% Cowpea +
5% WPC

70% Rice +
20% Cowpea
+ 10% WPC

60% Rice +
25% Cowpea +
15% WPC

50% Rice +
30% Cowpea +
20% WPC

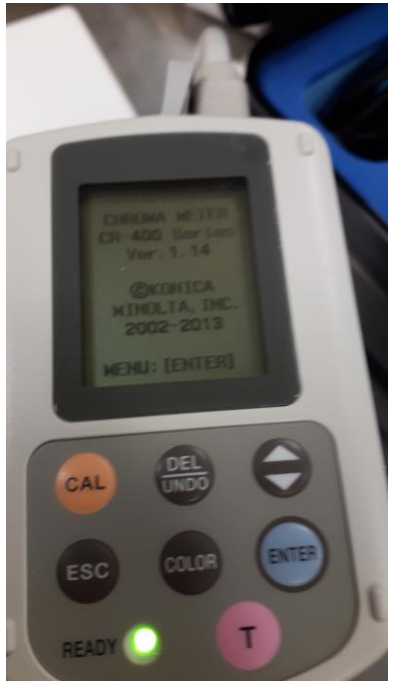
Colour Analysis

- L* (brightness), a* (redness) and b* (yellowness) - by using a tristimulus colour analyser (Minolta Chroma Meter CR 210, Minolta Camera Co., Japan).
- Total colour change (ΔE) and the browning index (BI) were calculated according to the following equations

✓ $\Delta E^* = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$

✓ $BI = \left(100 \times \frac{(X - 0.31)}{0.17}\right)$

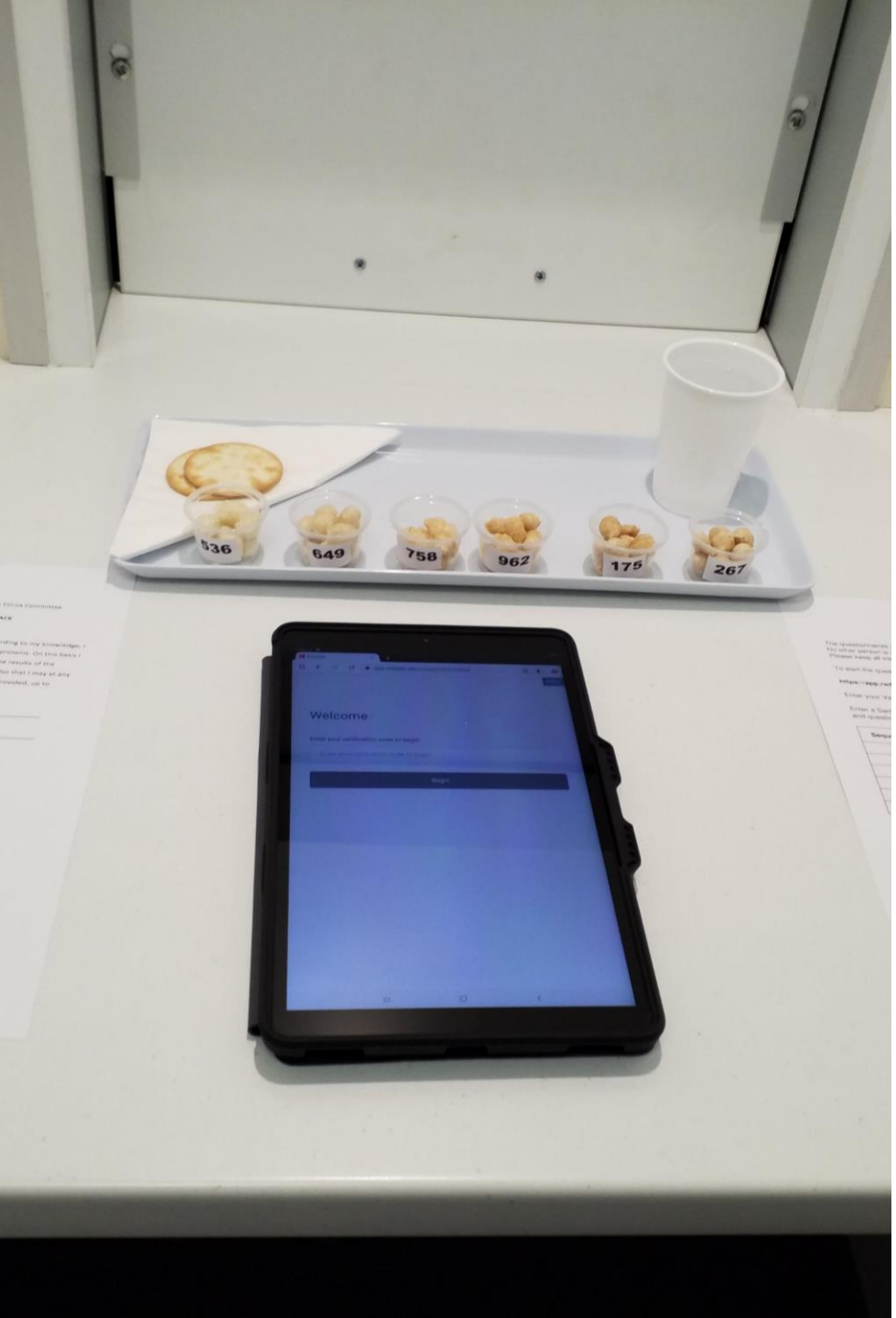
$$Where\ X = (a^* + 1.75)/(5.645L* + a^* - 0.3012b^*)$$



Texture Analysis

Crispiness, and Hardness

5-bladed Kramer Shear Cell(HDP/KS5), Texture Analyser equipped with a 50 kg load cell (TA.XT2; Stable Micro Systems, Godalming, UK)



Sensory Analysis

- Computerised questionnaires were administered (RedJade®Sensory Solutions, LLC, CA, USA)
- Consumers (N = 70) were recruited from the staff and postgrads students
- Each panellist was served five pieces of six extruded snack formulations, labelled with three-digit codes, following a counter-balanced presentation order
- Unsalted crackers and water were provided for palate cleansing

Statistical Analysis

- CATA (Check-All-That-Apply) data, Penalty analysis (JAR-Just above right), correspondence analysis was performed using XLSTAT statistical software (Addinsoft, NY, U.S.A.)

- Analysis of variance (ANOVA), and Tukey's tests($p<0.05$) were carried out to determine whether differences existed among treatments in terms of colour, texture and sensory liking scores

Results and Discussion

Instrumental texture and colour Analysis

Table 1. Mean values (and standard deviations) of colour and texture parameters

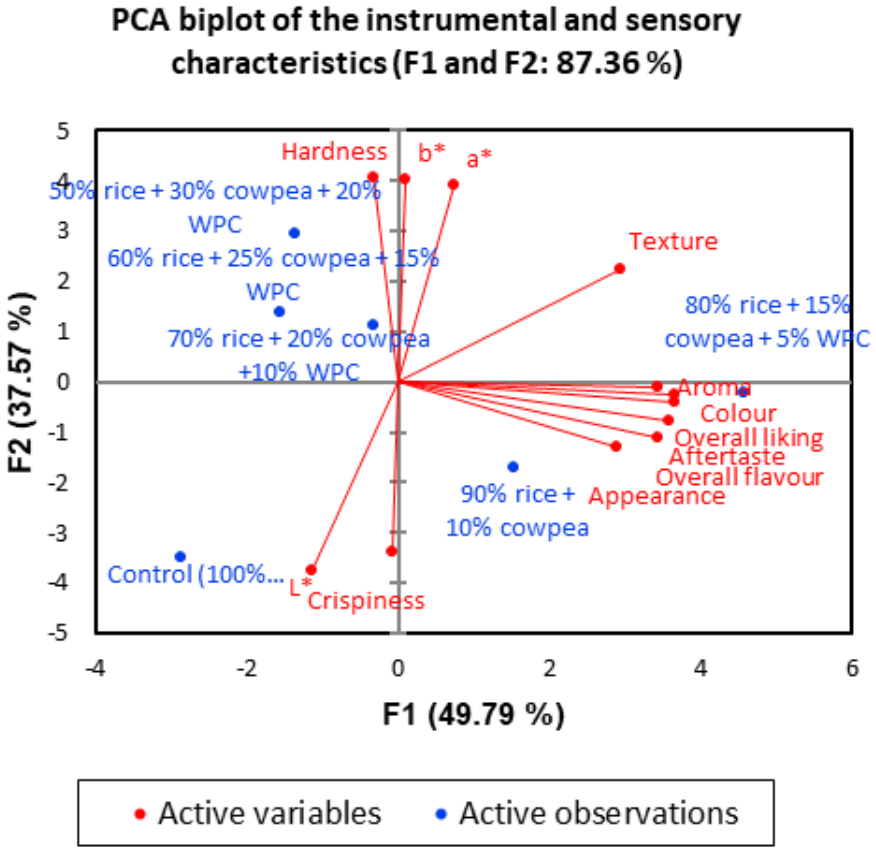
Sample	Colour Properties					Texture	
	L*	a*	b*	ΔE	BI	Crispiness	Hardness
Control	75.92 ± 0.93^{a}	-0.45 ± 0.02^{e}	12.24 ± 0.21^{d}	-	-	45.40 ± 6.23^{a}	223.35 ± 10.67^{c}
10% CPF	68.30 ± 0.98^{b}	0.32 ± 0.05^{d}	12.77 ± 0.46^{d}	7.69	20.56	39.80 ± 4.32^{a}	243.32 ± 12.88^{c}
15% CPF + 5% WPC	68.07 ± 0.65^{b}	2.26 ± 0.08^{c}	18.90 ± 0.79^{c}	10.65	34.29	37.80 ± 2.17^{a}	308.9 ± 32.3^{b}
20% CPF + 10% WPC	67.14 ± 0.72^{bc}	3.06 ± 0.13^{a}	21.62 ± 0.06^{a}	13.32	41.38	40.40 ± 1.14^{a}	326.2 ± 22.6^{b}
25% CPF + 15% WPC	65.93 ± 0.97^{c}	2.34 ± 0.09^{c}	20.07 ± 0.14^{b}	13.00	38.13	38.80 ± 1.30^{a}	339.11 ± 20.18^{b}
30% CPF + 20% WPC	65.75 ± 0.33^{c}	2.69 ± 0.12^{b}	21.83 ± 0.47^{a}	14.33	42.47	23.80 ± 6.83^{b}	446.11 ± 15.46^{a}

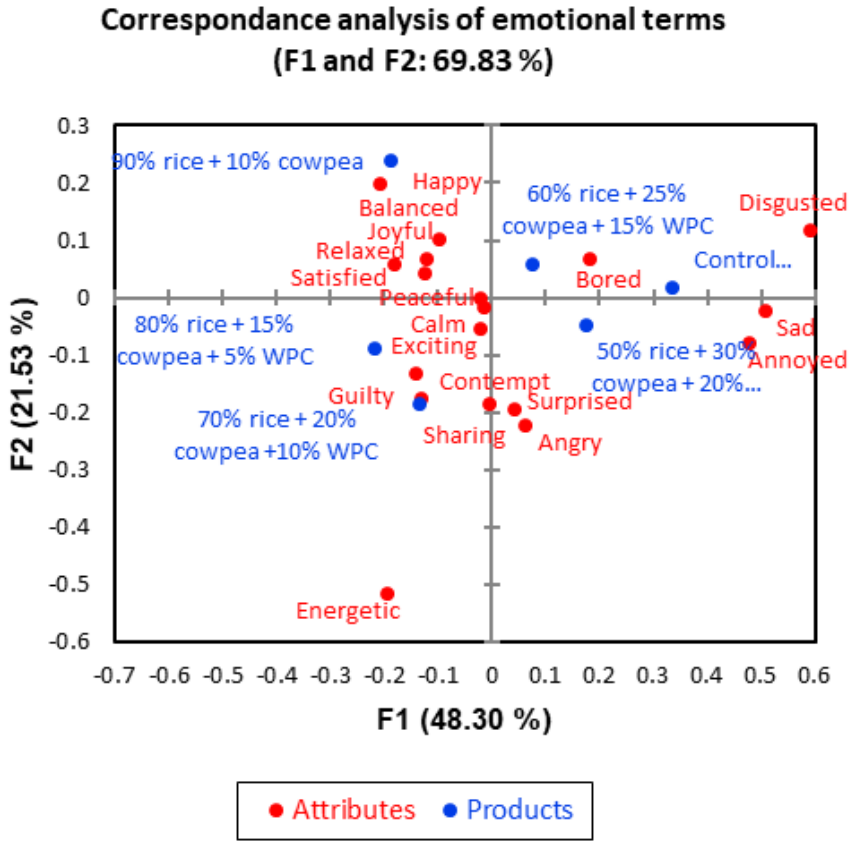
*The same letter in superscript within column indicates homogeneous groups established by ANOVA ($P < 0.05$).

Table 2. Mean scores (and standard deviations) of consumer responses based on a 9-point hedonic scale for sensory attributes

Sample	Appearance	Colour	Aroma	Overall flavour	Texture	After taste	Overall liking
Control	5.70 ±1.77^{a}	5.65± 1.77^{a}	5.44±1.30^{a}	5.17±1.50^{a}	5.29±1.71^{b}	5.04±1.77^{b}	5.11±1.65^{b}
10% CPF	5.69± 1.55^{a}	5.79±1.74^{a}	5.63±1.38^{a}	5.80±1.55^{a}	6.16±1.49^{a}	5.67±1.56^{ab}	5.77±1.44^{ab}
15% CPF + 5% WPC	5.97 ±1.52^{a}	6.19±1.31^{a}	5.73±1.34^{a}	5.89±1.85^{a}	6.36±1.51^{a}	5.99±1.80^{a}	6.07±1.53^{a}
20% CPF + 10% WPC	5.61± 1.48^{a}	5.73±1.58^{a}	5.56±1.40^{a}	5.24±1.61^{a}	6.04±1.50^{a}	5.41±1.58^{ab}	5.46±1.58^{ab}
25% CPF + 15% WPC	5.53 ±1.50^{a}	5.73±1.56^{a}	5.46±1.44^{a}	5.21±1.70^{a}	6.04±1.65^{a}	5.01±1.71^{b}	5.31±1.7^{ab}
30% CPF + 20% WPC	5.64±1.60^{a}	5.69±1.48^{a}	5.35±1.36^{a}	5.2±1.63^{a}	5.99±1.55^{ab}	5.06±1.74^{b}	5.20±1.64^{b}

*Mean values in the same row followed by different letters are significantly different ($P < 0.05$).





- Based on the CATA emotional terms selected by panellists, extruded snacks samples could be classified into two groups, i.e., 1) 10-20% cowpea and 5-10% WPC, and 2) 25-30% cowpea and 15-20% WPC
- 10-15% cowpea and 5% WPC incorporated snacks were associated with “happy”, “balanced”, “joyful”, “relaxed”, “satisfied”, “peaceful”, “calm” and “exciting”

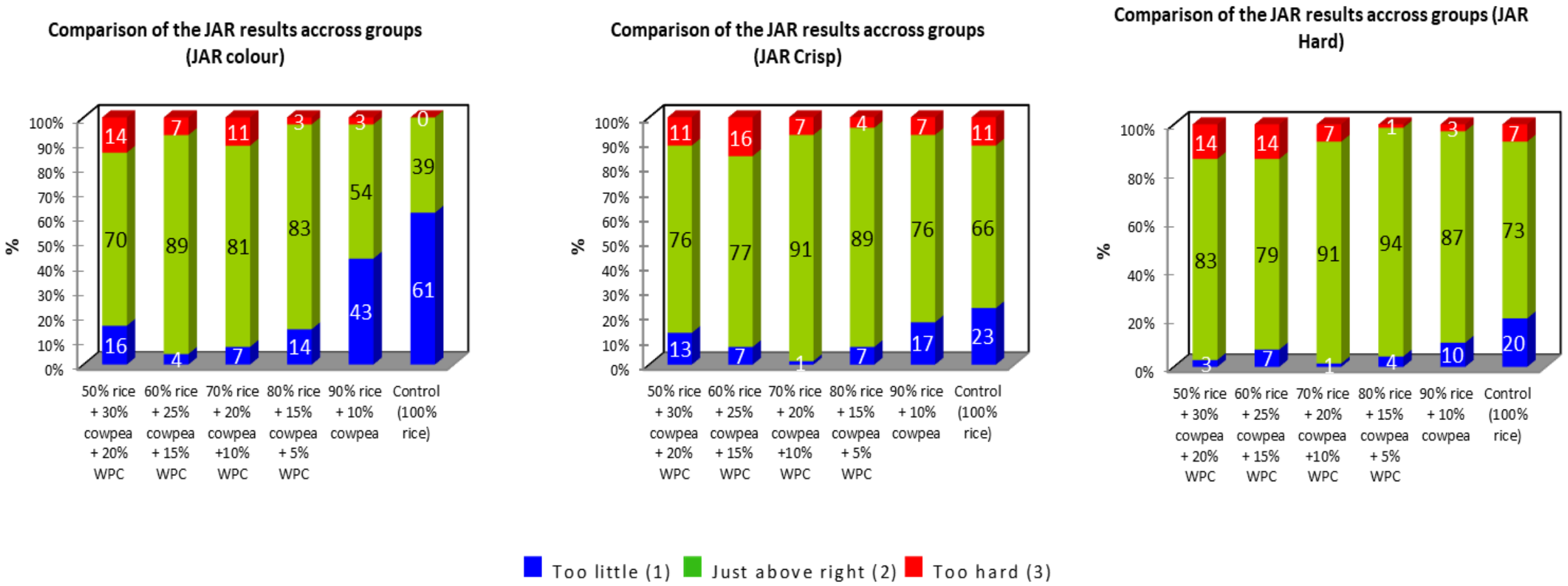


Figure 3 JAR results from consumer acceptance test for extrudates with (a) colour; (b) Crispiness; (c) Hardness

Overall, the percentage of consumers that rated the attributes as just about right increased in all categories with cowpea and WPC addition. Similarly, to hedonic scores, 15% cowpea flour and 5% WPC addition rated 83% for colour, 89% crispiness with 87% for hardness

Conclusion

- A cowpea-WPC based gluten-free extruded snack containing 10-15% Cowpea flour and 5% WPC was found to exhibit the most desirable consumer acceptability properties

90% Rice +
10% Cowpea

80% Rice +
15% Cowpea +
5% WPC

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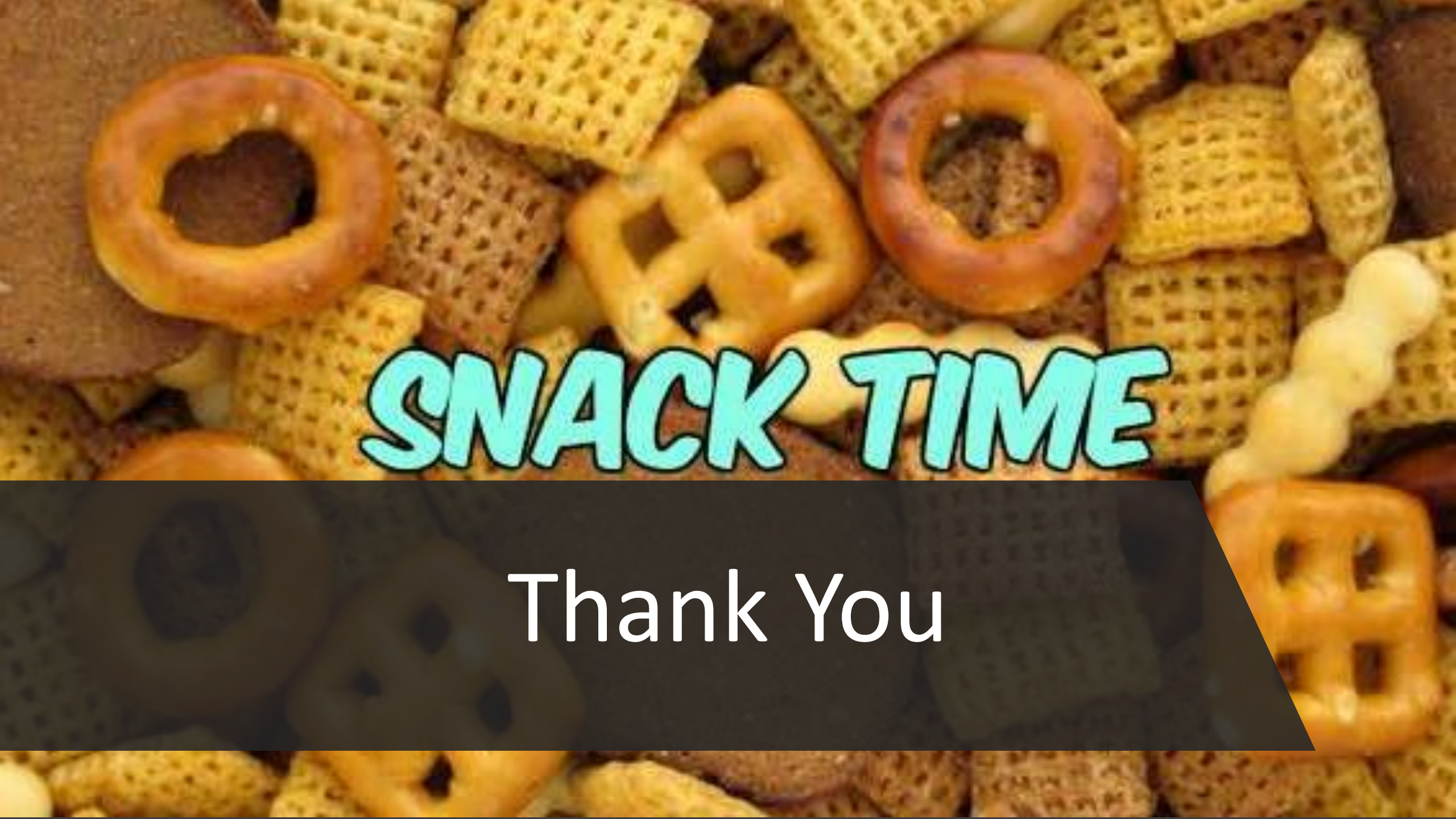

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