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Research Article

Assessing Sensory Characteristics and Consumer Preference of Legume-Cereal-Root Based Porridges in Nandi County

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Previously, porridge has been cereal based, consumed as a beverage or weaning food. Malnutrition among children has necessitated inclusion of legumes and roots in an effort to boost nutrient density. Therefore, the current study aimed at identifying the most acceptable porridge based on different food ingredient combination. Composite porridge flour included legumes (soybean, groundnut, and lablab), cereals (finger millet, sorghum, maize, and wheat), pseudocereals (pumpkin seed, buckwheat, and amaranth seed), and roots (cassava and arrowroot). New composite porridge flours were formulated using Nutrisurvey linear programming software. Different composite flours formulated to target either school-going children or a family setup were subjected to sensory analysis and the consumer preference test. Eight new formulations were developed. Buckwheat, wheat, and arrowroot were eliminated, maize and lablab content (%) were reduced, and cassava and finger were increased in the new formulations. A total of 149 participants composed of men (30.9%) and women (69.1%) aged between 11 and >60 yrs were interviewed. Newly formulated porridges were more preferred to the previous porridge formulations on color (40–54.2%), smell (40–52.4%), taste (41.5–47.5%), texture (58.3%), viscosity (35.4–45.8%), and overall acceptability (35–54.2%). The most cited reason for liking or disliking a particular porridge was taste (38.9%) and texture (32.2%), respectively. However, all the sensory attributes positively correlated with overall acceptability. Increased finger millet and cassava proportions in the newly formulated composite porridge flour highly influenced their high acceptability. Thus, consumer acceptability of new products is key for their adoption.

1. Introduction

Food-based interventions have been applied to reduce malnutrition and nutrition insecurity in Kenyan households [1, 2]. More attention has been paid to porridge which is popular in Kenya especially in rural areas and among low-income earners in urban areas. Adults take porridge as a beverage, while to children, it is a major weaning food [3, 4]. Unfortunately, most consumed porridges are starch based composed mostly of maize or cassava fortified with sorghum or finger millet [4], thus hardly meeting nutritional requirements of the consumers. This has encouraged introduction of legumes and different roots and tubers aiming on nutritional improvement of consumed porridge [5–7]. In addition, different flour processing and food fortification methods have been studied and adopted [4, 5, 8]. As a result, new formulation with different sensory attributes has been developed. This has necessitated the need for a consumer acceptability study of the newly developed product key on their adoption [6, 9].

As part of the efforts in curbing malnutrition in Nandi County, the current study aimed at developing most acceptable nutrient dense porridges targeting school-going children and a whole family setup.

2. Materials and Methods

2.1. Sample Collection. Sample ingredients collected for composite flour formulation included lablab (*Lablab purpureus*), soybean (*Glycine max*), groundnuts (*Arachis*

hypogaea), finger millet (*Eleusine coracana*), sorghum (*Sorghum bicolor*), maize (*Zea mays*), wheat (*Triticum aestivum*), buckwheat (*Fagopyrum esculentum*), amaranth seeds (*Amaranthus hypochondriacus*), pumpkin seeds (*Cucurbita* spp.), arrowroot (*Maranta arundinacea*), and cassava (*Manihot esculenta*). They were obtained from Kapkerer and Kiptaruswo farmer groups. The farmer groups involved themselves in processing legume-based porridge flour to economically empower their members and to mitigate malnutrition in children and vulnerable groups in Nandi County, Western Kenya. The farmer groups obtained the ingredients by purchasing from the neighboring Serem Market Centre or from their fellow members and stored them collectively in sacks. Respective ingredients stored in sacks were mixed before sampling 3 kg of each, packaged separately, and transported to food analysis laboratory at the University of Nairobi for further analysis.

2.2. Sample Preparation

2.2.1. Cleaning. All grains were sorted and graded for quality before wet cleaning and rinsing with tap water at ambient temperature. Arrowroot and cassava were trimmed off the mud, washed in tap water, and peeled.

2.2.2. Antinutrients Reduction. This was selectively done to soybean, groundnut, finger millet, and lablab as per previous study findings (unpublished work) aiming on phytate and tannins reduction. Soybean, groundnut, and finger millet were soaked (at room temperature 22–25°C) for 6 hours at a sample-to-water ratio of 1 : 2, while lablab was soaked at 1 : 3 for 24 hours (water was changed every 6 hours) and boiled for 60 min after the soaking treatment. The treated grains were dried in an air oven (Memmert, Germany) at 64 ± 2°C for 36 hours. Dried groundnut and soybean were roasted for 10 min at 174 ± 2°C in an air oven (Memmert, Germany).

2.2.3. Drying. Washed grains were oven-dried at 64 ± 2°C (Memmert, Germany) for 6 hours before further analysis. Cassava and arrowroot were chopped into thin pieces and then sun-dried until completely dry.

2.2.4. Grinding. A Black & Decker grinder was used, and the flour was sieved through 600 μm for uniformity.

2.3. Composite Flour Formulations. Chemical analysis findings (unpublished work) of each ingredient were input in Nutrisurvey linear programming software. The software is embedded with the World Health Organization (WHO) Recommended Dietary Allowances (RDA) of an expectant mother (4 months) that was used as a guideline in rationing each ingredient. The formulations targeted either school-going children or a whole family setup.

2.4. Porridge Preparation. Porridge was prepared by adding 250 g of composite flour in 400 ml of cold water before adding to 450 ml of boiling water. The mixture was brought to boil under continuous stirring, then left to continually boil for additional 15 min. The cooked gruel was immediately put in the thermos to keep hot.

2.5. Sensory Analysis. Sensory analysis was done against targeted consumers of each type of composite flour formulation. Sensory analysis of porridge targeting school-going children was done in respective farmers' group neighboring school while porridge targeting a family setup was done in the nearby shopping centre of respective farmers' group. The participants included upper primary pupils (Class 7 and 8) and adults. Porridge targeting school-going children was exclusively analyzed by the pupils, while porridge targeting a family set-up was analyzed by both juniors and adults. However, each participant analyzed only one classification of porridge.

Each participant was presented with three porridges (two newly formulated and the control), clean water for rinsing the mouth before and after tasting each porridge, a scooping spoon, and a scoring questionnaire where participants were asked to rank each porridge in order of preference on color, smell, taste, texture, viscosity, and overall acceptability. A rank of 1–3 was used (1: most preferred, 2: moderately preferred, and 3: least preferred).

2.6. Consumer Preference Test. The participants were presented with two open-ended questions for them to list the reason for disliking or liking most a particular porridge.

2.7. Data Analysis. After data cleaning, data obtained from the questionnaire were analyzed using Statistical Package for Social Sciences 16.0 software (SPSS) to get summaries, means, and other descriptive statistics.

3. Results

3.1. Composite Flour Formulations. Table 1 shows initial and newly formulated composite porridge flours targeting different demographics for each farmers' group. The proportion of each ingredient is shown in % for each composite flour. Initial formulations were A and B for Kiptaruswo and Kapkerer farmers' group, respectively. New formulation targeting school-going children and a family setup were C, D and G, H for Kiptaruswo and E, F and I, J for Kapkerer farmers' groups, respectively. Finger millet content was almost doubled in the new formulations from the initial formulations. Pumpkin seed was only available in Kiptaruswo farmers' group, while amaranth seed was only used in children flour. Cassava flour was increased from 12/13% to 22/43% in the new formulations, while lablab was decreased from 6/7% to 1% and limited to family flour formulations. Soybean and sorghum were also decreased from 3/6% and 6/19% to 3% and 2%, respectively, in family flour formulations. However, in children flour formulations, soybean was increased to 10/15% but sorghum was either slightly increased or decreased in respective farmers' group.

Table 1: Legume-cereal-root based flour formulation (%) for family and school-going children.

Ingredients	Initial formulations		New formulations							
			Children flour formulations				Family flour formulation			
	Kapkerer	Kiptaruswo	Kapkerer		Kiptaruswo		Kapkerer		Kiptaruswo	
Formulations*	B	A	E	F	C	D	I	J	G	H
Ingredients										
Maize	39	43	0	0	0	0	35	35	35	35
Millet	16	6	37	32	35	40	30	35	30	35
Pumpkin seed	0	2	0	0	1	1	0	0	1	1
Arrowroot	0	6	0	0	0	0	0	0	0	0
Buckwheat	0	3	0	0	0	0	0	0	0	0
Wheat	0	6	0	0	0	0	0	0	0	0
Groundnut	3	3	0	0	0	0	1	1	1	1
Amaranth seed	0	1	1	1	1	1	0	0	0	0
Cassava	13	12	37	37	38	43	28	23	27	22
Lablab	7	6	0	0	0	0	1	1	1	1
Soybean	3	6	15	10	10	10	3	3	3	3
Sorghum	19	6	10	20	15	5	2	2	2	2
Total (%)	100	100	100	100	100	100	100	100	100	100

3.2. Demographic Characteristics. Table 2 shows demographic characteristics of interviewed respondents. One hundred forty-nine respondents were interviewed comprising both men (30.9%) and women (69.1%). The respondents were interviewed for either children (70.5%) or family (29.5%) porridge from Kiptaruswo (59.7%) or Kapkerer (40.3%) farmers' group. The majority of the respondents were in 11–20 yrs (77.2%) age bracket still continuing with primary education (71.1%).

Table 2: Demographic characteristics of the study population.

Characteristics		N	Percentage (%)
Group name	Kiptaruswo	89	59.7
	Kapkerer	60	40.3
Sex of participants	Female	103	69.1
	Male	46	30.9
Types of porridge	Family	44	29.5
	Children	105	70.5
Age of respondents	11–20	115	77.2
	21–30	6	4.0
	31–40	11	7.4
	41–50	7	4.7
	51–60	7	4.7
	>60	3	2.0
Level of education	Primary school drop out	12	8.0
	Continuing primary	106	71.1
	Completed primary	3	2.0
	Continuing secondary	10	6.7
	Completed secondary	8	5.4
	Secondary drop out	2	1.3
	Tertiary level	8	5.4

3.3. Sensory Ranking of Different Porridges

3.3.1. Children Porridge Sensory Evaluation. Figures 1 and 2 show the most preference ranking (%) score of porridges against sensory attributes (color, smell, taste, texture, viscosity, and acceptability) targeting school-going children for Kiptaruswo and Kapkerer farmers' group, respectively. Initial flour formulation for Kiptaruswo farmers' group (A) scored (%) the least in the most preference scale (10.8–16.9), while formulation C (29.2–47.7) and D (35.4–52.4) were most preferred. However, formulation C scored slightly higher than D only on texture (47.7%) and overall acceptability (46.2%).

In Kapkerer's formulations (Figure 2), initial formulation B scored (%) lower (20–27.5) than the new formulations E (32.5–47.5) and F (20–42.5). Formulation E scored the highest in all sensory attributes except in texture where formulation F (42.5%) scored higher.

3.3.2. Family Porridge Sensory Evaluation. Figures 3 and 4 represent the most preference ranking score of Kiptaruswo and Kapkerer family porridge, respectively. In the Kiptaruswo's family flour formulations (Figure 3), H formulations was the most liked (%) in most parameters (40–58.3) followed by G (33.3–41.7) while A was the least liked (4.2–16.7%). In Kapkerer family flour formulations (Figure 4), formulation I was most liked (%) (20–45) in most parameters except in color and texture where initial formulation (B) scored the highest at 60% and 55%, respectively. However, B was least liked on viscosity (25%) and acceptability (30%); therefore, formulation I was the most preferred.

3.4. Consumer Preference of Developed Porridges. Table 3 shows reasons given by respondents for liking/disliking a porridge and what they valued the most in the porridge. Taste was the most contributing factor for the respondent in liking porridge (38.9%) while color (10.7%) contributed the least. Porridge texture (32.2%) and taste (26.8%) were the most cited reasons for disliking a porridge. Porridge taste was the most considered factor on choosing

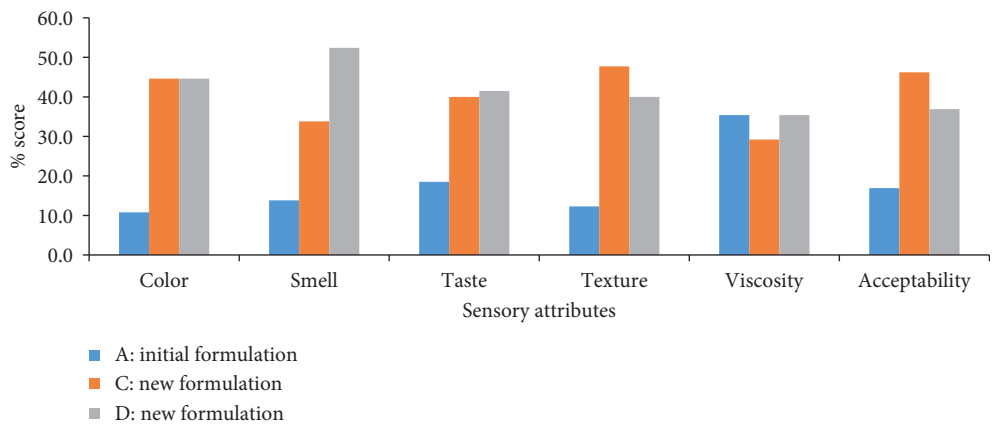

Figure 1: Preference ranking (%) of Kiptaruswo's children porridge against different sensory attributes.

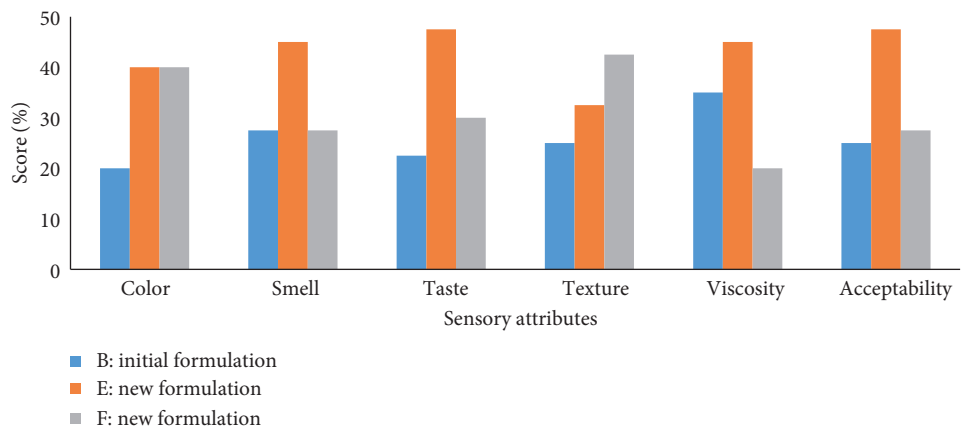

Figure 2: Preference ranking (%) of different Kapkerer's children porridge against different sensory attributes.

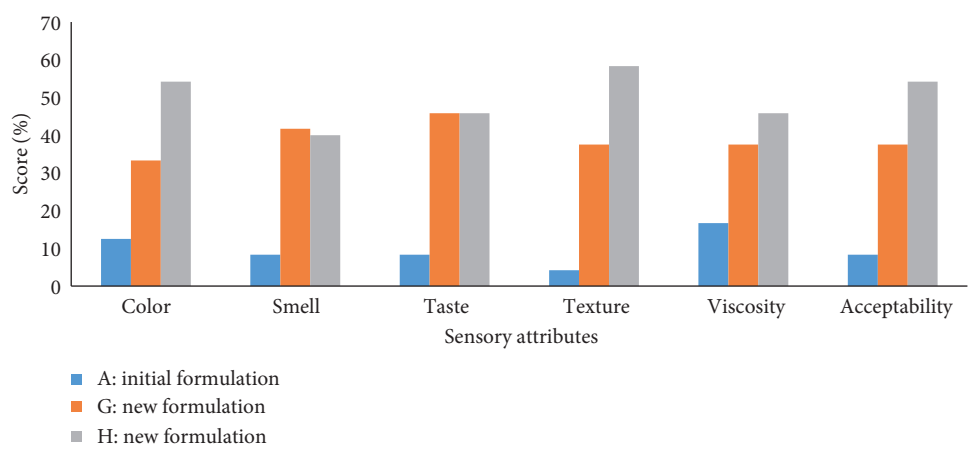

Figure 3: Preference (%) ranking of different Kiptaruswo's family porridge against different sensory attributes.

the porridge ingredients especially to the school-going children. However, to the elderly and those with a medical condition, nutrition was the most important factor.

3.5. Correlation of Sensory Attributes with Porridge Acceptability. Table 4 shows the correlation of the most liked attribute of porridge with the most acceptable porridge. All the sensory attributes positively correlated with porridge acceptability. Porridge viscosity was the least influencing factor while color, taste, and smell were the most influential. Smell was the most influencing factor to Kiptaruswo's respondents liking a porridge while taste and texture highly influenced the liking of Kapkerer's porridges. Thus, they were the most distinctive characteristics among the respective porridges presented. Viscosity insignificantly

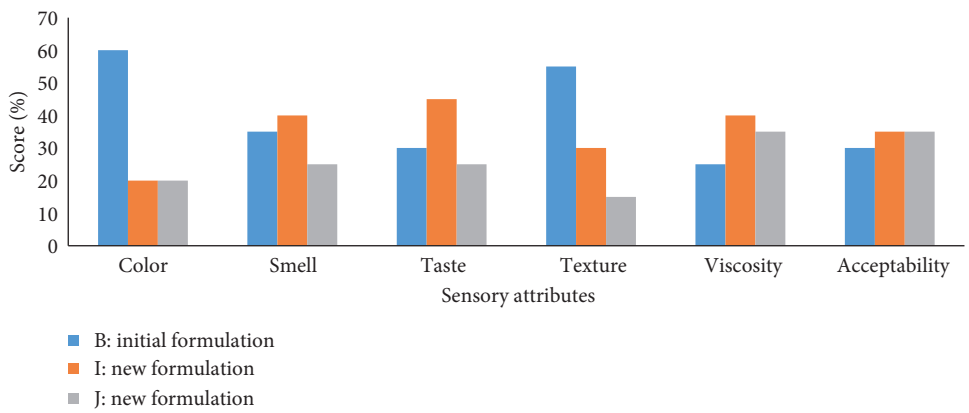

Figure 4: Preference ranking (%) of different Kapkerer's family porridge against different sensory attributes.

Table 3: Consumers' reason for liking/disliking of developed porridges and factors considered attributed to preferences.

Attributes	Attributes liked (%)	Attributes disliked (%)	Most important factors in porridge (%)	
Color	10.7	12.1	Nutrition	2.7
Smell	14.1	9.4	Color	5.4
Taste	38.9	26.8	Taste	79.2
Texture	18.8	32.2	Smell	8.7
Viscosity	17.5	19.5	Texture	2.7
			Viscosity	1.3
Total	100.0	100.0		100.0

Table 4: Correlation of most liked porridge attributes with most acceptable porridge.

Flour type	Sensory attributes				
	Color	Smell	Taste	Texture	Viscosity
Kiptaruswo children porridge	0.414 (0.001**)	0.730 (0.001**)	0.560 (0.000**)	0.502 (0.000**)	0.440 (0.000**)
Kapkerer children porridge	0.498 (0.001**)	0.419 (0.007**)	0.571 (0.000**)	0.681 (0.000**)	0.245 (0.128)
Kiptaruswo family porridge	0.775 (0.000**)	0.851 (0.000**)	0.702 (0.000**)	0.342 (0.102)	0.598 (0.002**)
Kapkerer family porridge	0.031 (0.897)	0.413 (0.071)	0.508 (0.022*)	0.203 (0.391)	0.235 (0.319)

The values in bracket are the p values. Those which were significantly different at ($p < 0.01$) and ($p < 0.05$) are indicated with asterisk (**) and (*) respectively.

($p > 0.05$) influenced the acceptability of Kapkerer porridges while in Kiptaruswo porridges, it was significant ($p < 0.05$). In Kiptaruswo and Kapkerer children porridges, smell (0.730) and texture (0.681), respectively, were the most influencing factors, while in respective farmers' group, smell and taste were the most influential factors in family porridges.

4. Discussion

Groundnut is known to have allergic reactions especially in children; hence, it was eliminated in children flour formulations [10, 11]. Buckwheat, wheat, and arrowroot were eliminated from the new formulations following their scarcity in the market and high cost. Cassava and finger millet are highly utilized due to their desirable texture and taste, respectively [4], thus their increase in the new formulations. Maize content was decreased since chemical analysis finding indicated it being less nutritious in comparison to other ingredients (unpublished work). Roasted flavor of soybean is desirable in porridge; hence, its use increases in the new formulations, while the additional boiling step of lablab known to reduce phytate and tannin [2, 12, 13] would resultantly be expensive to the farmers' group (unpublished work); hence, it has limited utilization in the new formulations.

Despite porridge being a common meal or beverage among the Nandi residents, men were less responsive than women to the sensory analysis, hence their fewer number. Sensory analysis for porridge targeting school-going children was done in respective farmers' group neighboring school compound. As a result, there were more respondents analyzing for porridges targeting school-going children in comparison to respondents analyzing for a family setup porridges. This also explains the high respondents in the school-going category. However, different demographic characteristics have been reported [3, 7].

New formulations had higher proportion of finger millet, cassava, and soybean than initial formulations. Finger millet taste is highly preferred in porridge [4]; hence, it has

increased proportion in new formulations. Cassava was found to be the least fibrous (unpublished work) among the ingredients used; thus, its high proportion in the new formulations influenced the smooth texture of the porridge, thus higher preference of the same. Legumes-containing porridge is highly disliked due to the imparted undesirable beany flavor [7]. This was taken care of by roasting soybean and groundnut which produced a desirable flavor and boiling lablab. Hence, the higher liking for the new formulations on smell was seen despite some having higher soybean proportions. Similar measures were taken by Ndagire et al. [6]. Thus, higher finger millet, soybean, and cassava proportions in new formulations would explain the higher preference of the new formulations on taste, smell, and texture in comparison to the initial formulations.

Texture was the main reason given by respondents on disliking some porridges especially the initial formulations. The rough texture was probably contributed by higher maize constituents in the initial formulations whose flour would not be as fine as cassava flour which was increased in the new formulations. More so, despite the flour having been finely ground and sieved, some hard irregularly shaped particles detectable in the mouth than the round shaped particles may have passed through the sieve, hence the undesirable texture.

Starch composed largely of amylose and amylopectin essential in development of desired porridge viscosity. Amylose is linear while amylopectin is branched at C-6 making it more stable in solutions [14]. During cooking, depending on moisture content and heating rate [15], starch granules absorb water thus gelatinizing to form a gel [4] desirable in porridge cooking [6]. However, since porridge was served at a lower temperature than the cooking temperature (temperature not likely to scald the respondents) viscosity of the porridges increased. Retrogradation which is time and temperature-dependent affecting viscosity, texture, and sensory perception [15] of starchy products may have happened. The increased viscosity may have been to the dislike (19.5%) or like (17.5%) of some respondents, respectively. More so, maize porridge has been found to be more viscous than finger millet porridge [6]. This further explains the least preference of the initial formulations which had higher maize content against the newly formulated porridges across the target groups. Similar functional characteristic studies on porridge have been done [6, 7, 15].

All the sensory attributes positively correlated with porridge acceptability though at different strengths. Taste and texture were the most influential largely contributed by high finger millet and cassava proportion in the new formulations, respectively. This further explains the higher acceptability of the new formulations against the initial formulations. Comparable findings were reported by Kikafunda et al. [9]; however [7], they found color as the strongest correlating factor in meat.

5. Conclusion

The sensory evaluation indicates higher preference of newly developed formulations which contained higher finger millet and cassava content. Taste and texture were the most influencing factors on porridge preference. Thus, formulations D, E, H, and I were the most acceptable.

Data Availability

The data used to support the findings of this study are available as supplementary materials.

Conflicts of Interest

The authors declare no conflicts of interest regarding publication of this article.

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Supplementary Materials

(1) Composite Flours Formulation. This is an excel sheet calculation showing how different composite flours targeting specific demographics were formulated. The formulation was targeted to meet 100% of the Recommended Dietary Allowance (RDA) of each target group as per the World Health Organization (WHO) recommendations except fats which would cause rancidity in flour. Depending on the nutritional density of each ingredient, the RDA for each formulation was achieved to varying levels as shown in the calculation below each formulation. *(2) Demographic Characteristics of the Study Population*. This is a summary of characteristics of the respondents who participated in the sensory evaluation of the developed composite porridge flours. The table shows their number per group, type of porridge, sex, level of education, and age. *(3) Ranking (%) of Porridges Sensory Attributes*. This table shows the ranking of each porridge flour per target group on selected sensory parameters (color, smell, taste, texture, viscosity, and acceptability). *(4) Reason for Liking/Disliking a Porridge and Most Valued Characteristic of the Porridge*. The table scores the reasons that make porridge consumers like or dislike a porridge and the most influencing aspect of the porridge for them to want it. (*Supplementary Materials*)

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