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Formulation and Development of Cubed Coffee with Agarwood Leaf Extract Powder

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Abstract

Coffee is one of the most popular beverages in our surroundings. A real adventure is hidden behind each hot and flavorful cup of coffee, which can be served in a variety of ways. However, mixed coffee drinks in the form of cubes with the addition of agarwood leaf powder were not available in the market. The study aims to fill a market gap by exploring the creation of mixed coffee drinks in cube form with agarwood leaf powder. This innovative approach not only offers a unique coffee experience but also explores consumer preferences and sensory characteristics, ultimately contributing to the overall acceptability of the product. A study involving agarwood leaf powder in coffee cubes was conducted to explore consumer preferences and preferences in this study, consumer acceptability of Agarwood leaf extract powder was assessed using a 7-point hedonic scale and sensory characteristics were determined using a descriptive test. Untrained and trained panels from UTHM and trained food technology students participated. Skim milk and soymilk formulations were evaluated for appearance, odor, texture, sweetness, bitterness, taste, aftertaste and overall acceptability. Skimmed milk formulation 1 showed the highest acceptance, followed by formulations 3 and 2. Soymilk formulation 3 received the highest acceptance, followed by formulations 2 and 1. Descriptive tests showed significant differences in flavor, bitterness and acidity ($p < 0.05$). The skim milk formulations showed no differences in overall acceptability, appearance, aroma, texture, bitterness and aftertaste, but differences in taste and sweetness. Soymilk formulations showed differences in overall acceptability, taste, bitterness, sweetness, aftertaste, appearance, aroma and texture. Results revealed popular versions and specific flavors, potentially inspiring new coffee experiences

1. Introduction

Coffee production consists of a variety of processes, ranging from additional processing to industrial processing, in which the raw fruit is transformed into finished coffee. The coffee fruits are usually harvested by the owners of the coffee plantations and sold as green beans to various companies. There are several end products in the marketing of coffee, but the most important are roasted beans and ground coffee. The coffee industry includes a wide range of products for different consumption habits, ranging from instant coffee to the use of single-capsule

espresso machines [1]. Agarwood is widely used in the production of incense, perfume, and medicine, as well as in religious rites and as adornment [2].

Nowadays, the coffee drink has become a phenomenon in all walks of life around the world, especially in Malaysia. Malaysia ranks 60th in the world and contributes only about 0.16% of global coffee production [3]. Consumer preferences in the coffee industry are influenced by factors like scent, taste, strength, acidity, and sweetness, as well as brewing techniques like drip, espresso, or cold brew, according to a study by Gavrieli and Herstein[4]. But in the instant coffee market, in the form of a cube containing the same ingredients as the instant coffee already in the market, it is very rare to find due to lack of innovation and limited variety in the instant coffee market, especially in the cube coffee product segment.

There is a gap in the market for instant cubed coffee products that incorporate Agarwood leaf extract powder, a distinctive and aromatic ingredient with potential to enhance the flavor profile and offer a unique coffee experience. This could offer a unique and distinctive product, catering to changing tastes. Agarwood, known for its refined properties, is a valuable ingredient in perfumery and incense, but its potential as a flavor enhancer in the coffee industry is yet to be fully explored. Agarwood Leaf contains tannin, saponin, and cardiac glycoside chemicals, but no alkaloid. Tannin is a harsh, bitter-tasting chemical with a polyphenol cluster that may attach to and precipitate proteins [5].

The project aims to address these challenges by developing a recipe for instant coffee in cube form with Agarwood leaf extract powder that incorporates the unique aromatic properties of Agarwood and offers a distinct flavor profile to meet the changing preferences of coffee consumers. The importance of this study is to develop a cube-shaped milk coffee with an additional flavor which is agarwood leaf extract powder. As a starting point with, agarwood leaf extract powder is a distinct and potentially valuable component that can enhance the flavour and aroma profiles of coffee.

2. Materials and Method

2.1 Cleansing of Agarwood leaf

The Agarwood leaf cleaning process involved a meticulous dual-step approach. Firstly, the leaf were cleansed with tap water to remove any dirt, followed by a rinse with deionized water for enhanced purification. Post-cleaning, the leaf underwent a careful drying process, ensuring the removal of excess water. The final step involved subjecting the dried leaf to a smokehouse at 80°C for 2 hours, effectively eliminating any residual moisture. This systematic process guaranteed the cleanliness and dryness of Agarwood leaf, setting the stage for further processing.

2.2 Extraction of Agarwood Leaf

The extraction technique utilized for Agarwood leaf involved soaking the powdered leaf in deionized water at a 1:50 ratio [6], maintaining the combination at 90°C for 30 minutes in a water bath. Subsequently, the mixture of leaf underwent filtration using Whatman Filter No. 1. The water extract was then chilled before being employed in the spray drying process.

2.3 Spray Drying of Agarwood Leaf Extract

Spray drying was carried out by incorporating the chosen carrier agent combination, following the method outlined by [7], [8] with minor modifications. Maltodextrin, the selected carrier agent, was added to the Agarwood leaf aqueous extract at a concentration of 15%. The plant extract mixture underwent spray drying using a spray dryer with inlet temperatures ranging between 150 - 180 ºC. The feed had a flow rate of about 10 - 20 rpm, and a nozzle size of 0.7 mm was used. The resulting powdered plant extract was stored in a tight container for subsequent testing.

2.4 Development of samples

The formulation for coffee cubes was created by combining the following ingredients: coffee Arabica, sugar, milk powder, and powdered Agarwood leaf extract [9]. Once all the components were thoroughly combined, water was gradually added while continuously mixing for three to five minutes to ensure a homogeneous mixture. Subsequently, the coffee cube mixture was poured into molds arranged on trays to shape cubes. To achieve consistency and level the mixture, gentle pressure was applied. The cube molds were then disassembled, and the trays with the coffee cubes were transferred to a food dehydrator. The cubes underwent drying at a controlled temperature of 50±2 °C for approximately two hours. Following the drying process, the cubes were allowed to cool to room temperature.

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2.5 Panelist sensory evaluation

The sensory testing panel was selected from the nearby vicinity of the UTHM campus. Fifty-one individuals, comprising both untrained and trained panels, were recruited for hedonic testing. Additionally, 40 trained panelists, specifically students from UTHM's Food Technology program and other programs have also participated in the sensory evaluation, participated in the descriptive test. Invitations were extended to the panelists.

2.6 Providing samples

Each panel was presented with six samples formulated using skimmed milk powder and soymilk powder. (a) formulation 1 using skimmed milk (4% agarwood leaf powder). (b) formulation 2 using skimmed milk (3% agarwood leaf powder). (c) formulation 3 using skimmed milk (2% agarwood leaf powder). (d) formulation 1 using soymilk (4% agarwood leaf powder). (e) formulation 2 using soymilk (3% agarwood leaf powder). (f) formulation 3 using soymilk (2%agarwood leaf powder).

Table 1 *Coded samples of Coffee Cubed with ALEP*

Coded samples	Coffee cubed with ALEP
614	Formulation 1 (skimmed milk powder)+(4% ALEP)
147	Formulation 2 (skimmed milk powder)+(3%ALEP)
499	Formulation 3 (skimmed milk powder)+(2%ALEP)
273	Formulation 1 (soymilk powder)+(4% ALEP)
375	Formulation 2 (soymilk powder)+(3% ALEP)
794	Formulation 3 (soymilk powder)+(2%ALEP)

2.7 Hedonic testing

Fifty-one untrained and trained panellist each were presented with coded samples in small cup (Table 1) and assess how much they like the taste, appearance, and odour of the samples. The scale used in hedonic test is 7-point hedonic scale ((1=dislike very much, 2= dislike moderately, 3=dislike slightly, 4=neither like nor dislike, 5=like slightly, 6= like moderately, 7=like very much) [10].

2.8 Descriptive test

Forty-four trained panelists were presented with coded samples in Table 1 and asked to assess the intensity of each attribute of aroma, sweetness, bitterness, acidity, and aftertaste. The panelist assessed the intensity of each attribute by five-point scale (1: for not present, 2: for threshold, 3: for slight, 4: for moderate and 5: for strong).

2.9 Statistical analysis

In order to compare the means of two or more independent groups and ascertain whether there is statistical support that the related population means are statistically substantially different, one-way analysis of variance (ANOVA) was use [11] and (Minitab) One-way ANOVA.

3. Results and Discussion

3.1 Yield of spray dried agarwood leaf

Agarwood leaf that had been water removed were sprayed dried and powdered using a carrier agent, which is maltodextrin. By spraying the feed into a hot drying medium, the spray drying technology turns fluid feed into dried powder. The percentage yield of spray dried agarwood leaf is 900 grams.

3.2 Acceptance test method

The three samples of coffee cubed with agarwood leaf extract powder with skimmed milk powder were ranked according to their mean ratings for appearance, aroma, taste, and overall acceptability using a 7-point hedonic scale by google form. The coffee cubed with ALEP formulation 2 has the highest appearance mean score (5.060), followed by the coffee cubed formulation 1(4.765) and the formulation 3(6.11). The appearance average means scores of 5 showed the panelist like slightly the appearance of coffee cubed with ALEP (skimmed milk powder).

For aroma attributes, cubed coffee with ALEP formulation 1 has the highest mean score (5.118). The second-highest mean scores are (4.824) for formulation 3 and (4.745). These values are for formulation 2. The aroma average mean scores of 4 indicates panelists neither like nor dislike the aroma of cubed coffee with ALEP (skimmed milk powder). Furthermore, for texture attributes of cubed coffee with ALEP (skimmed milk powder), the highest mean scores are formulation 1 (5.314) followed by formulation 2 and formulation 3 which are (4.980) and (4.961) respectively. Average mean scores for texture attributes are 4 indicates panelists neither like nor dislike the texture of cubed coffee.

Formulation 1 obtained the highest mean score (5.529) in the taste attributes of three formulations, suggesting overall good response. Formula 3 had a respectable score (4.941), surpassing formula 2 which is (4.627). While Formulation 2 got the lowest mean score, it does suggest opportunities for development. Average mean scores of 5 indicating panelist like slightly for the taste of coffee. The three formulations' mean bitterness scores were evaluated, with formulation 1 receiving the highest score (4.922), followed by formulations 3 and 2 (4.745) and (4.706) respectively. Average mean score of 5 indicates panelist like slightly for the taste of coffee. Formulation 1 had the highest mean sweetness score of (5.333), indicating that it tastes significantly sweeter than formulations 2 and 3 (means of 4.529 and 4.745, respectively). Average mean scores for sweetness attributes are 5 indicating panelists light slightly the sweetness of coffee.

For the aftertaste characteristic, formulation 1 had mean scores of (5.392), formulation 2 received mean ratings of (4.784), and formulation 3 received mean values of (4.961). The highest overall acceptability of cubed coffee is formulation 1 with mean scores of (5.373). The second highest mean score is (5.120) which belongs to formulation 3 followed by formulation 2 with mean scores of (4.922). Average mean scores of 5 indicates panelist like slightly the overall sensory cubed coffee (refer Table 2).

Table 2 *mean scores of coffee cubed with ALEP (skimmed milk) for acceptance test*

Attribute	**Samples skimmed milk**			
	Formulation 1	Formulation 2	Formulation 3	Result
Overall acceptance	5.373±1.280	4.922±1.309	5.120±1.534	Not Significant
Appearance	4.765±1.450	5.060±1.331	4.959±1.607	Not Significant
Aroma	5.118±1.478	4.745±1.481	4.824±1.545	Not Significant
Texture	5.314±1.581	4.980±1.655	4.961±1.612	Not Significant
Taste	5.529±1.317	4.627±1.496	4.941±1.605	F1 & F3 =Significant F2 = Not significant
Bitterness	4.922±1.623	4.706±1.501	4.745±1.635	Not Significant
Sweetness	5.333±1.337	4.529±1.488	4.745±1.585	F1 & F3 =Significant F2 = Not significant
Aftertaste	5.392±1.401	4.784±1.514	4.961±1.637	Not Significant

*Data are expressed as the Mean±Standard Deviation (SD)

The three coffee cube samples with agarwood leaf extract powder with soymilk powder were evaluated based on their average scores for appearance, aroma, taste, and overall acceptability. The coffee cubes formulation 3 with ALEP gets the highest appearance mean score (4.725), followed by formulations 1 and 2 (4.431 and 4.480, respectively). In terms of smell, particularly aroma characteristics, cubed coffee with ALEP formulation 3 obtains the highest average score (4.314). The formulations with the second-highest mean scores are (4.275) and (3.980), respectively. The average mean score for aroma, which is 4, suggests that panelists are undecided about the aroma of cubed coffee with ALEP (soymilk powder). Additionally, formulation 3 (4.824) had the highest mean ratings for the texture attributes of cubed coffee with ALEP (soymilk powder), followed by formulations 1 and 2, at 4.686 and 4.490, respectively. Panelists appreciate the texture of cubed coffee somewhat, as shown by average mean ratings for texture attributes of 5.

Formulation 3 had the highest mean score (4.588) in the taste attributes, indicating a generally positive reaction. Formula 2 outperformed Formula 1 with a solid score of 4.020, outperforming 3.216. The mean bitterness scores of the three formulations were evaluated; formulation 3 scored the highest (4.176), followed by formulations 2 and 1 (4.078) and (3.373), in that order. The results of the taste test indicate that the sweetness profiles of the three formulations varied. Formulation 3 tastes significantly sweeter than formulations 1 and 2 (means of 4.000 and 3.118, respectively), as indicated by its highest mean sweetness score of (4.451). Formulation 3 obtained mean ratings of (4.549), formulation 2 received mean ratings of (4.078), while formulation 1 received mean values of (3.294) for the aftertaste attribute. Formulation 3, which received the highest mean score, had a more satisfying and enduring aftertaste.

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According to Table 3, formulations 3 and 1 have the greatest overall acceptance of cubed coffee, with mean ratings of the same (4.294), followed by formulation 1 with mean scores of (3.804). A panellist's average mean score of 4 suggests that they are undecided about the overall acceptance cubed coffee.

Table 3 *mean scores of coffees cubed with ALEP (soymilk) for acceptance test*

Attribute	**Samples using soymilk**			
	Formulation 1	Formulation 2	Formulation 3	Result
Overall acceptance	3.804±1.549	4.294±1.579	4.294±1.433	F1 & F3 =Significant F2 = Not significant
Appearance	4.480±1.515	4.431±1.664	4.725±1.550	Not Significant
Aroma	3.980±1.476	4.275±1.576	4.314±1.530	Not Significant
Texture	4.686±1.703	4.490±1.592	4.824±1.596	Not Significant
Taste	3.216±1.604	4.020±1.606	4.588±1.746	F2&F3 = Not significant F1= Significant
Bitterness	3.373±1.536	4.078±1.495	4.176±1.621	F1 & F3 =Significant F2 = Not significant
Sweetness	3.118±1.351	4.000±1.386	4.451±1.514	F2&F3 = Not significant F1= Significant
Aftertaste	3.294±1.689	4.078±1.547	4.549±1.566	F2&F3 = Not significant F1= Significant

*Data are expressed as the Mean±Standard Deviation (SD)

Table 4 shown p-value indicates whether there is a significant difference between the cubed coffee samples with ALEP (skimmed milk powder) with three distinct formulations; a significant difference is there if the p-value is less than 0.05, and not at all if it is more than 0.05. According to table 4.5, there are no significant differences between the parameters which are overall acceptance, appearance, aroma, texture, bitterness and aftertaste. The p-value of each parameter which are overall acceptance, appearance, aroma, texture, bitterness and aftertaste are 0.0257, 0.590, 0.420, 0.466,0.766 and 0.119 respectively which (p>0.05). It can be concluded that the panelist cannot differentiate between the sample of coffee cubed with ALEP (skimmed milk powder).

Table 4 *Summary ANOVA of Cubed Coffee with ALEP (Skimmed milk) acceptance test*

Sensory Attributes	**Degree of Freedom**	**Sum of square**	**Mean Square**	***F*-value**	***P*-value**	**Result**
Overall acceptance	2	5.211	2.605	1.37	0.257	Not significant
Appearance	2	2.278	1.139	0.53	0.590	Not significant
Aroma	2	3.935	1.967	0.87	0.420	Not significant
Texture	2	4.013	2.007	0.77	0.466	Not significant
Taste	2	21.39	10.693	4.90	0.009	Significant
Bitterness	2	1.346	0.6732	0.27	0.766	Not significant
Sweetness	2	17.66	8.830	4.07	0.019	Significant
Aftertaste	2	9.974	4.987	2.16	0.119	Not significant

*Data are expressed as the Mean±Standard Deviation (SD)

In accordance with Table 5, there are significant differences between the parameters which are overall acceptance, taste, bitterness, sweetness, and aftertaste. The *p*-value of each parameter which are overall acceptance, appearance, aroma, texture, bitterness, and aftertaste are 0.006, 0.000, 0.019, 0.019, 0.000 and 0.001 respectively which (p>0.05). Therefore, for parameter appearance, aroma, and texture there are no significant differences. The p-value of each parameter for these 3 parameters are 0.603, 0.486 and 0.585. It can be concluded that the panelist can differentiate between the sample of coffee cubed with ALEP (soymilk powder).

Table 5 *Summary ANOVA of Cubed Coffee with ALEP (Soymilk) acceptance test*

Sensory Attributes	Degree of Freedom	Sum of square	Mean Square	*F*-value	*P*-value	Result
Overall acceptance	2	24.51	12.255	5.29	0.006	Significant
Appearance	2	2.531	1.265	0.51	0.603	Not significant
Aroma	2	3.386	1.693	0.73	0.486	Not significant
Texture	2	2.863	1.431	0.54	0.585	Not significant
Taste	2	48.51	24.255	4.90	0.000	Significant
Bitterness	2	19.62	9.810	4.08	0.019	Significant
Sweetness	2	46.92	23.458	11.65	0.000	Significant
Aftertaste	2	40.99	20.497	7.99	0.001	Significant

*Data are expressed as the Mean±Standard Deviation (SD)

3.3 Descriptive test method

The sensory attributes of coffee cubed formulations, utilizing both skimmed milk powder and soymilk powder, were evaluated on a 5-point scale. According to table 6, the aroma attribute in skimmed milk powder formulations, Formulation 1 scored the highest at 3.950, followed by Formulation 3 (3.825) and Formulation 2 (3.300). Similarly, in soymilk powder formulations, Formulation 1 led with a mean score of 3.800. Regarding sweetness, Formulation 1 outperformed in both skimmed milk (3.500) and soymilk (3.400) formulations. Bitterness displayed distinct patterns, with Formulation 3 being perceived as the most bitter in both skimmed milk (3.750) and soymilk (3.550) formulations. Acidity levels varied, with Formulation 2 having the highest acidity in skimmed milk formulations (3.725), while in soymilk formulations, Formulation 2 led with a mean of 3.825. For aftertaste, Formulations 2 and 3 shared the highest score in skimmed milk (3.775), while in soymilk, Formulation 1 led with a score of 3.825. These findings offer insights into the nuanced sensory profiles, providing valuable information for formulation adjustments and product development.

Table 6 *Mean scores sensory attributes of coffee cubed with ALEP (skimmed milk powder and soymilk powder) for descriptive test*

Attributes	Samples					
	F1 (614)	F2 (147)	F3 (499)	F1 (273)	F2 (375)	F3 (794)
Aroma	3.950±0.714 Not significant	3.300±1.224 Significant	3.825±0.931 Not significant	3.800±0.992 Not significant	3.650±0.975 Not significant	3.525±0.987 Not significant
Sweetness	3.500±1.198 Not significant	3.300±1.224 Not significant	3.400±1.105 Not significant	2.500±1.062 Not significant	3.000±1.301 Significant	3.400±1.057 Not significant
Bitterness	3.050±0.876 Significant	3.625±0.979 Not significant	3.750±1.149 Not significant	3.550±1.319 Not significant	3.300±1.344 Not significant	3.375±1.234 Not significant
Acidity	2.250±1.104 Not significant	3.725±0.905 Significant	2.600±1.081 Not significant	2.475±1.109 Not significant	2.825±1.174 Not significant	2.575±1.174 Not significant
Aftertaste	3.525±0.987 Not significant	3.775±0.733 Not significant	3.775±0.974 Not significant	3.825±1.130 Not significant	3.550±1.176 Not significant	3.625±1.234 Not significant

*Data are expressed as the Mean±Standard Deviation (SD)

The ANOVA results for formulations using skimmed milk powder reveal significant differences in sensory attributes. Aroma, Bitterness, and Acidity exhibit significant variations among formulations, as indicated by their respective *F*-values (4.97, 5.49, and 22.22) and low *P*-values (0.008, 0.005, and 0.000) (refer Table 7). This suggests that the formulations contribute significantly to the perceived differences in these attributes. Conversely, Sweetness and Aftertaste show non-significant differences, with *F*-values of 0.29 and 1.02 and higher *P*-values (0.750 and 0.365). Thus, these attributes are not substantially influenced by the choice of

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formulations. In summary, the choice of formulation significantly affects Aroma, Bitterness, and Acidity in skimmed milk powder-based products, while Sweetness and Aftertaste remain relatively consistent across formulations.

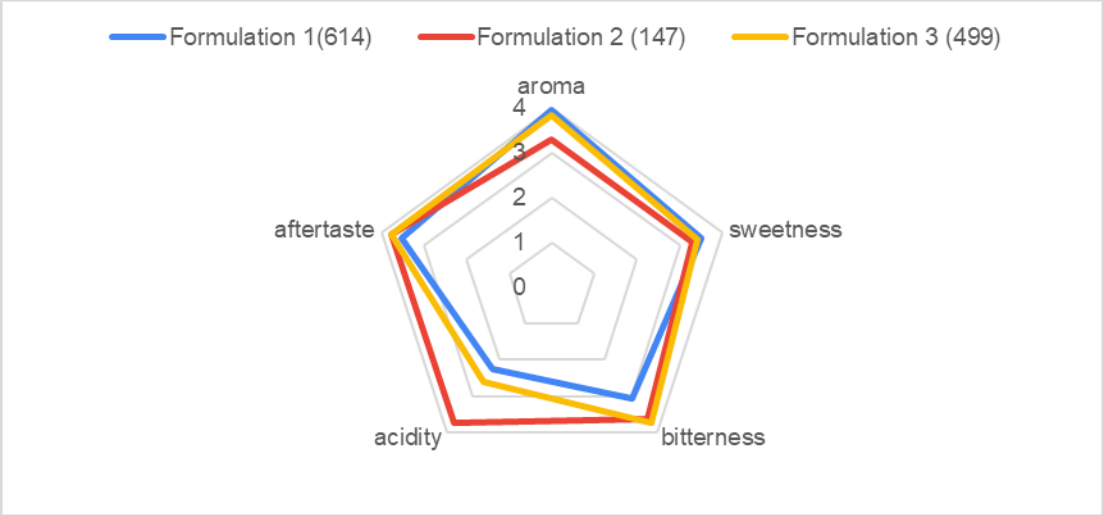

Fig. 1 *Quantitative descriptive analysis (QDA) of cubed coffee using skimmed milk powder for descriptive test*

Table 7 *Summary of ANOVA for formulation using Skimmed milk powder*

Sensory Attribute	Sum of Square	Degree of freedom(df)	Mean square	*F*-value	*P*-value	Result
Aroma	9.517	2	4.7583	4.97	0.008	Significant
Sweetness	0.800	2	0.400	0.29	0.750	Not significant
Bitterness	11.12	2	5.575	5.49	0.005	Significant
Acidity	47.52	2	23.758	22.22	0.000	Significant
Aftertaste	1.667	2	0.8333	1.02	0.365	Not significant

The ANOVA outcomes for soymilk powder formulations highlight a significant impact on sweetness, as indicated by a substantial *F*-value of 6.20 and a low *P*-value of 0.003. This underscores the formulations' significant influence on perceived sweetness in soymilk powder-based products. However, attributes such as Aroma, Bitterness, Acidity, and Aftertaste show non-significant differences, with higher *P*-values (0.460, 0.678, 0.379, and 0.561, respectively) as depicted in Table 8. This suggests that the choice of formulations does not markedly affect aroma, bitterness, acidity, and aftertaste in soymilk powder-based products. In summary, sweetness is distinctly impacted by formulation choice, while other sensory attributes exhibit relative consistency across the tested formulations.

Table 8 *Summary of ANOVA for formulation using Soymilk powder*

Sensory Attribute	Sum of Square	Degree of freedom(df)	Mean square	F-value	P-value	Result
Aroma	1.517	2	0.7583	0.78	0.460	Not Significant
Sweetness	16.27	2	8.133	6.20	0.003	Significant

Bitterness	1.317	2	0.6583	0.39	0.678	Not Significant
Acidity	2.600	2	1.300	0.98	0.379	Not Significant
Aftertaste	1.617	2	0.8083	0.58	0.561	Not significant

4. Conclusion

In summary, the evaluation, in which 51 UTHM students participated as trained and untrained panelists, revealed that the acceptability of cubed coffee was influenced by the choice of milk and the taste of Agarwood leaf extract powder. Formulations with skim milk powder were preferred, with formulation 1 (4% agarwood leaf powder) being favored. The formulations with soymilk powder received a neutral rating, indicating that there was little awareness of coffee with soy milk, and formulation 3 (2%) was preferred. In the descriptive test with 40 trained panelists, formulation 2 performed best for the skim milk powder formulations, while formulation 3 was ahead for the soymilk powder formulations. These results illustrate the influence of the choice of milk and the concentration of agarwood leaf powder on the sensory profile and consumer preference of cubed coffee. The cubed coffee initiative with powdered Agarwood Leaf extract presents opportunities for improvement and growth. The first step is determining the optimal proportion of Agarwood Leaf extract to coffee. Shelf-life stability, creative packaging, market research, and scalability are crucial for success. An ongoing sensory assessment system will ensure product flexibility and commercial viability.

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Conflict of interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author contribution

The authors confirm contribution to the paper as follows: ***study conception and design****: Muhammad Aimil Qayyum bin Rukhaizad, Balkis A. Talip;* ***data collection****: Balkis A. Talip****; analysis and interpretation of results****: Muhammad Aimil Qayyum bin Rukhaizad, Balkis A. Talip****; draft manuscript preparation****: Muhammad Aimil Qayyum bin Rukhaizad, Balkis A. Talip. All authors reviewed the results and approved the final version of the manuscript.*

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