BIOLOGY, MEDICINE, & NATURAL PRODUCT CHEMISTRY ISSN 2089-6514 (paper)
Volume 14, Number 2, October 2025 | Pages: 1021-1028 | DOI: 10.14421/biomedich.2025.142.1021-1028 ISSN 2540-9328 (online)

Formula Optimization and Sensory Analysis of Functional Collagen Drink from Butterfly Pea Flower (*Clitoria ternatea* L.) and Red Guava (*Psidium guajava* L.)

Anjar Asmarani Widya Nabilah*, Ela Marcelia, Tri Dewanti Widyaningsih, Kiki Fibrianto
Food Science and Biotechnology Department, Faculty of Agricultural Technology, University of Brawijaya,
Jl. Veteran No. 10-11, Ketawanggede, Lowokwaru, Malang, Indonesia 55145, Indonesia.

Corresponding author*
anjarasmaraniwn@gmail.com

Manuscript received: 23 May, 2025. Revision accepted: 04 November, 2025. Published: 13 November, 2025.

Abstract

The global market for functional beverages is experiencing rapid growth as consumer awareness for healthy lifestyles increases. The objective of this study is to ascertain the physical characteristics, optimal formula, and organoleptic quality of functional collagen beverages derived from a blend of *bayang* flower (*Clitoria ternatea* L.), red guava (*Psidium guajava* L.), and *emprit* ginger. In this study, an extreme vertex design was employed in conjunction with Minitab 19 to extract the materials. The extraction process was carried out using the following methods: *telang* flowers were subjected to a drying process at 40°C for 24 hours, followed by extraction with water at 60°C for 30 minutes; ginger emprit was dried at 60°C for 24 hours and then extracted at 55°C for 15 minutes; and red guava was blended with water at a 1:1 ratio. The total phenolic content was analyzed using the Folin-Ciocalteu method, while antioxidant activity was evaluated through the use of the DPPH method. Finally, sensory evaluation was conducted employing a hedonic test, which was completed by 100 untrained panelists. The optimal formula obtained was 50% *telang* flower extract, 30% red guava juice, 15% ginger *emprit* extract, and 5% collagen hydrolysate (desirability value 0.8288), resulting in antioxidant activity of 316.45 mg TE/100 ml and total phenolic content of 247.33 mg GAE/L. The sensory evaluation revealed that the subject demonstrated moderate acceptance, as indicated by an average preference score of 3.51. The combination of bay flower extract and guava juice exhibited a synergistic effect in enhancing antioxidant activity, while guava juice contributed significantly to the total phenolic content. Notwithstanding the favorable reception, the robust ginger flavor, elevated viscosity, diminished clarity, and textural characteristics.

Keywords: Functional Drink; Collagen; Butterfly Pea; Red Guava; Antioxidant.

INTRODUCTION

The global market for functional beverages is already experiencing substantial growth. The phenomenon under consideration occurred in conjunction with an increase in consumer awareness regarding the maintenance of a healthy lifestyle. Functional beverages have emerged as the most rapidly expanding product category within the food and beverage sector, with a primary objective of enhancing bioactive compound bioavailability (Gupta et al., 2023). As new products continue to be developed and the stability and availability of bioactive products increases, market projections indicate that functional drinks will experience continuous growth (Nazir et al., 2019)

Development and consumption of functional beverages have gained significant importance in addressing consumer demand for healthy products, with the potential to enhance public health, quality of life, and reduce the risk of degenerative diseases (Carvalho et al., 2023). The ingestion of functional beverages fortified with antioxidants, fiber, and other bioactive compounds has been demonstrated to play a pivotal role in the mitigation of risk factors associated with various health complications and accelerated aging (Aron, 2019). The protective mechanisms underlying this effect include the alleviation of oxidative stress, the regulation of blood sugar levels, the enhancement of lipid profiles, and the reduction of inflammation (Yilmaz-Akyuz et al., 2019)

The development of functional beverages with optimal physicochemical and organoleptic characteristics necessitates a comprehensive scientific approach. The theory of functional beverage formula optimization utilizes a mixture design method (Hassanzadeh et al., 2022). The interaction of hydrolyzed collagen with other bioactive compounds has been demonstrated to enhance thealth benefits (Bilek & Bayram, 2015)

As demonstrated in prior research, the incorporation of hydrolyzed collagen into fruit juice beverages has been observed to enhance the protein content and bioavailability of these beverages. Additionally, it has been observed to modify the levels of ascorbic acid, total phenols, and antioxidant capacity within these functional beverages (Bilek & Bayram, 2015). Most studies focus on collagen drinks made from a single ingredient or a combination of ingredients. However, the combination of butterfly pea flowers and guava has the potential to produce functional collagen drinks with unique physical characteristics, formulas, and sensory qualities.

The goal of this study is to determine the physical characteristics, optimal formula, and organoleptic quality of functional collagen beverages made from a mixture of butterfly pea flowers, guava and *emprit* ginger. Adding collagen to guava- and butterfly pea flower-based beverages has the potential to enhance the product's nutritional value and sensory characteristics.

MATERIALS AND METHODS

Procedures

This research was conducted at Food Nutrition Laboratory and Sensory Laboratory of Faculty of Agricultural Technologym University of Brawijaya. The butterfly pea flowers were collected from the OBET plantation in Malang. Red guava and emprit ginger were purchased from the Gadang market in Malang. Marine collagen was purchased from PT. Maxcorp Global Indonesia. Liquid stevia was purchased from Berlico Indonesia. All chemical reagents (DPPH, Folin-Ciocalteu, sodium carbonate, distilled water, and analytical-grade methanol) were purchased from a local drugstore in Malang.

The tools used was knufe, alumunium tray, blender, hotplate stirrer, waterbath shaker, homogenizer, erlenmeryer, spaltula, test tube, measuring pipette, Ohaus analytical balance, and cabiner dryer.

Figure 1. Butterfly Pea Flower (*Clitoria ternatea).*

Sample Preparation

The butterfly pea flowers were cleaned and dried at 40°C for 24 hours in a cabinet dehydrator. After drying, the butterfly pea flowers were ground using a grinder to increase the surface area. The ground butterfly pea flowers were extracted using drinking water at 60°C for 30 minutes at a ratio of 3 g/L using a hot plate stirrer to form butterfly pea extract (Duy et al. 2020). Emprit ginger was sliced (1 mm) and dried (60°C, 24 hours) in a dehydrator. The dried emprit ginger was ground and extracted using drinking water at 55°C for 15 minutes to form emprit ginger extract. Red guava fruits were blended with water at a ratio of 1:1 (w/v) and filtered with a filtration cloth. The butterfly pea extract, emprit ginger extract, and guava juice were analyzed for total phenolic content and antioxidant activity. Collagen powder was weighed, then dissolved in water at a ratio of 1:2 (w/v). Functional drinks were made by mixing butterfly pea flower extract, guava juice, ginger extract, and collagen based on the formula design. Then, they were homogenized using an Ultra-Turrax homogenizer at 1800 rpm for 10 minutes and pasteurized at 77°C for 2 minutes. Each formula was analyzed for total phenolic content and antioxidant activity.

Formula Optimization.

An extreme vertex design was used with Minitab version 19 to determine the optimal formulation for a functional butterfly pea drink. This design is often used in mixture experiments where constraints are applied to each factor. In this study, the whole design was replicated twice, and the total amount of each component was set to 100% for flexibility. This model resulted in 18 runs, each of which produced a composite (Table 1). Each run was analyzed for total phenolic content and antioxidant activity. Finally, all 18 runs were used to empirically determine the optimum formula using the response optimizer in Minitab version 19.

Total Phenolic Content Determination

Total phenolic content was determined as a result of formula optimization according to the Folin-Ciocalteu method described by Singleton et al. (1999), with slight modifications. Each formulation was diluted with a dilution factor of 12.5 (2 mL of the sample was pipetted and diluted to a 25-mL volumetric flask) using distilled water. Then, 0.5 mL of the diluted solution was pipetted into a test tube, and 4 mL of Folin-Ciocalteu reagent was added. Then, 5 ml of a 7.5% sodium carbonate solution was added. The solution was incubated in a dark room for 30 minutes.

Antioxidant Activity Determination

The antioxidant activity of FBD was determined using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity method according to Thaipong et al. (2006), with slight modifications. After centrifugation at 6,000 rpm for 5 minutes, 2 mL of the supernatant was transferred to a test tube. Then, 2 mL of 0.2 mM DPPH in methanol were added. The mixture was incubated for 30 minutes in the dark. The absorbance of each sample was determined using a UV-Vis spectrophotometer at a wavelength of 517 nm. The antioxidant activity was expressed as milligrams of Trolox equivalent per liter using a Trolox standard curve (0, 5, 10, 15, 20, and 25 ppm) in methanol.

Sensory Evaluation

The selected formulations were subjected to a hedonic test based on preferences for fishy odor, ginger aroma, fruity flavor, sour flavor, sweetness, ginger flavor, synthetic flavor, viscosity, solubility, sandy texture, and overall liking and acceptability. The attributes were rated from 1 to 5 (1 = dislike very much, 2 = dislike, 3 = quite like, 4 = like, and 5 = like very much) based on the panelist preferences for each attribute using 100 untrained panelists (male-to-female ratio unknown).

Data analysis

One-way analysis of variance (ANOVA) with a 95% confidence interval was used to identify differences between treatments in Minitab 19. If the results showed significant differences, a post hoc test was carried out using the Tukey pairwise comparison test to determine which pairs of group means were significantly different from each other.

RESULTS AND DISCUSSION

Bioactive Composition of Single Ingredients

The antioxidant activity and total phenolic content of the individual ingredients were analyzed to establish a baseline for further formulation of a functional butterfly pea drink with collagen (FBDC). As demonstrated in Table 1, ginger extract demonstrated the most significant antioxidant activity (317.36 ± 3.00 mg TE/100 ml), followed by butterfly pea flower extract (136.59 ± 1.76 mg TE/100 ml) and red guava juice (61.64 ± 2.38 mg TE/100 ml).

Table 1. Bioactive Composition of Single Ingredients.

Sample	Antioxidant activity (mg TE/ 100 ml)	TPC (mg GAE/L)
Blue pea flower extract	136,59 ± 1,76	248,801 ± 5,01
Emprit ginger extract	317,37 ± 3,00	235,920 ± 0,86
Red guava juice	61,64 ± 2,38	411,677 ± 4,35

Bioactive Composition of Individual Runs

The optimization analysis of 18 formulations designed using Minitab 19 software is presented in **Table 2**. The findings revealed variations in antioxidant activity, ranging from 232.24 to 395.23 milligrams of Trolox equivalent (TE)/100 milliliters, and in total phenolic content, ranging from 141.28 to 260 milligrams of gallic acid equivalent (GAE)/liter. These variations are indicative of the impact of varying ingredient proportions on the observed responses. In order to assess the relative contributions of the various components, a dual approach was utilized, encompassing both statistical modeling through regression analysis and empirical methods facilitated by mixture design visualizations.

Table 2. Bioactive Composition of Individual Runs for Functional Butterfly Pea Drink with Collagen.

Formula	Butterfly Pea Extract (%)	Red guava juice (%)	Emprit ginger extract (%)	Collagen hydrolysate (%)	Antioxidant activity (mg TE/100 ml)	TPC (mg GAE/L)
F1	50,25	28,25	15,25	6,25	378,193	190,084
F2	50,00	30,00	15,00	5,00	309,104	260,444
F3	50,25	29,25	15,25	5,25	290,036	203,702
F4	50,50	28,50	15,50	5,50	367,632	221,860
F5	50,25	28,25	16,25	5,25	235,208	227,534
F6	50,00	28,00	15,00	7,00	357,222	203,135
F7	52,00	28,00	15,00	5,00	321,232	184,978
F8	50,25	29,25	15,25	5,25	343,062	254,202
F9	52,00	28,00	15,00	5,00	315,099	222,427
F10	51,25	28,25	15,25	5,25	348,740	152,635
F11	51,25	28,25	15,25	5,25	335,128	196,893
F12	50,00	30,00	15,00	5,00	320,131	234,910
F13	50,00	28,00	17,00	5,00	338,141	162,848
F14	50,25	28,25	15,25	6,25	362,640	175,331
F15	50,25	28,25	16,25	5,25	232,340	162,848
F16	50,00	28,00	17,00	5,00	281,936	169,657
F17	50,00	28,00	15,00	7,00	395,237	164,551
F18	50,50	28,50	15,50	5,50	376,839	141,287

Optimization of Composite

The optimization of a functional beverage formulation using butterfly pea flower extract, red guava juice, ginger extract, and collagen hydrolysate resulted in an optimal formula with a ratio of 50:30:15:5, respectively. This formulation achieved a desirability value of 0.8288, indicating its alignment with the ideal conditions for maximizing antioxidant activity and total phenolic content. As demonstrated in Figure 2, the recommended formula yielded 316.45 milligrams of total antioxidant activity (TE) per 100 milliliters and 247.33 milligrams of gallic acid equivalent (GAE) per liter of total phenolic content.

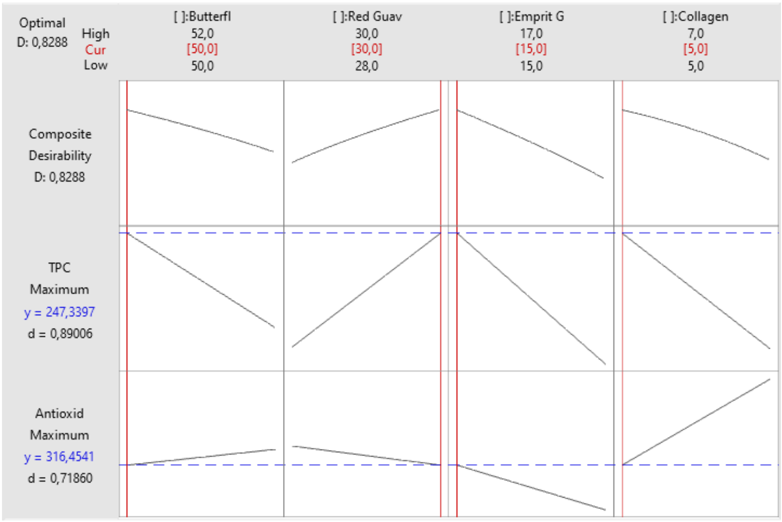

Figure 2. Desirability plot of butterfly pea flower extract, red guava juice, emprit ginger extract, and hydrolysate collagen to antioxidant and TPC.

Effect of Optimization Process on Mixture Components

Regression coefficients for antioxidant activity and total phenolic content (TPC) responses are presented in Table 3. A linear regression model was selected due to statistically significant p-values ($p < 0.05$) for both responses and a non-significant lack of fit ($p > 0.05$) for TPC. Although the antioxidant response showed significant lack of fit, higher-order models did not improve the model significantly due to high data variability. The R^2 values were 43.37% for antioxidant activity and 44.86% for TPC, indicating moderate predictive capability.

Antioxidant activity = 3,667A – 0,248B – 10,579C + 22,063D
TPC = –4,103A + 24,324B – 14,997C – 10,458D

Note: A = Butterfly Pea flower extract (%); B = red guava juice (%); C = emprit ginger extract (%); D = collagen hydrolysate (%)

Antioxidant Response Analysis

The effect of butterfly pea flower extract, red guava juice, and ginger extract on antioxidant activity was analyzed under constant collagen concentration (5%). The findings demonstrated that considerable proportions of butterfly pea extract attained increases in antioxidant activity, surpassing 320 mg TE/100 ml. This hypothesis was corroborated by the graphical surface response and contour plots, which visually identified the optimal antioxidant response in formulations with higher concentrations of butterfly pea extract, as shown in the surface and contour plots in Figure 3.

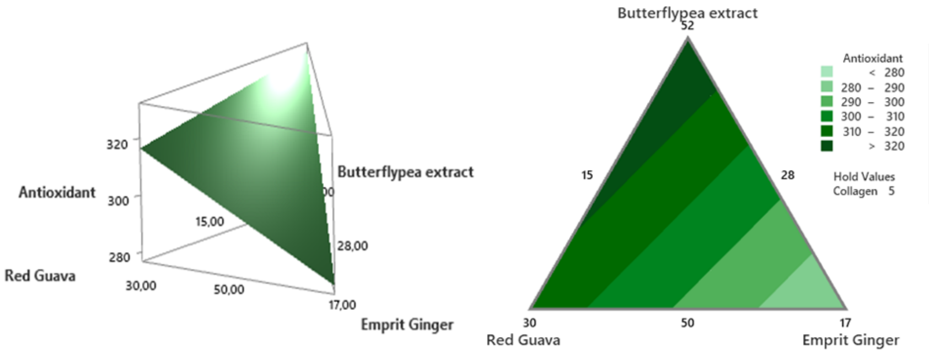

Figure 3. Surface plot antioxidant (left), Contour plot antioxidant (right) of F.

Total Phenolic Content Response Analysis

The formulation of a functional beverage using butterfly pea flower extract, red guava juice, and ginger extract was evaluated to determine its effect on total phenolic content, with the collagen concentration fixed at 5%. The optimization process revealed that red guava juice significantly contributed to the increase in total phenolic content, particularly when used in higher proportions. This trend is manifested by elevated surface regions and darker green areas in the contour plot, indicating total phenolic values exceeding 240 milligrams of gallic acid equivalent per liter (Figure 4).

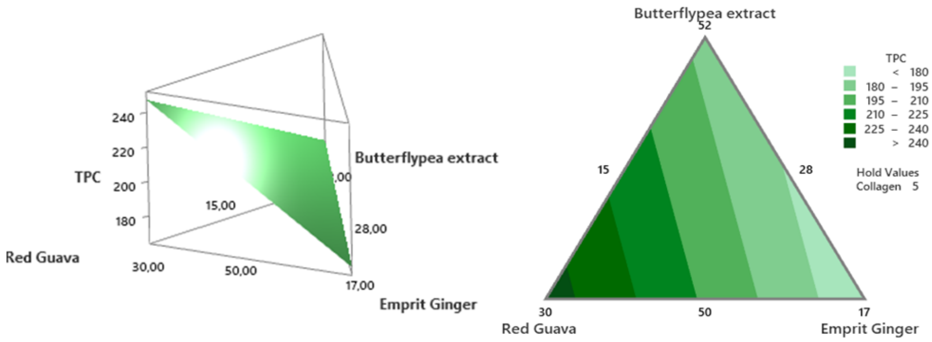

Figure 4. Surface Plot Total Phenolic Content (left), Contour Plot Total Penoloc Content (Right).

Sensory Evaluation

The hedonic test results for the FBDC, FBDNC, and commercial product samples are presented in Table 3.

Table 3. Result of sensory evaluation for FBDC, FBDNC, dan Commercial product.

Sensory Atributes	FBDC	FBDNC	Commercial	P-Value
Ginger Aroma	3.66 ± 0.87^{a}	3.50 ± 0.96^{ab}	3.21 ± 1.31^{b}	0.003
Fishy Odor	3.50 ± 0.84^{a}	3.58 ± 0.82^{a}	3.54 ± 1.13^{a}	0.817
Ginger Flavor	3.00 ± 1.17^{b}	2.77 ± 1.13^{b}	3.36 ± 1.19^{a}	0.000
Synthetic Flavor	2.94 ± 0.91^{a}	2.92 ± 0.93^{a}	3.17 ± 1.20^{a}	0.096
Fruity Flavor	3.78 ± 0.70^{a}	3.86 ± 0.65^{a}	3.98 ± 0.99^{a}	0.205
Sweetness	3.83 ± 0.72^{a}	3.61 ± 0.81^{a}	3.86 ± 1.10^{a}	0.086
Sourness	3.58 ± 0.62^{a}	3.50 ± 0.71^{a}	3.74 ± 0.82^{a}	0.060
Viscosity	3.40 ± 0.86^{b}	3.50 ± 0.79^{b}	4.06 ± 0.86^{a}	0.000
Clarity	2.93 ± 0.81^{b}	3.02 ± 0.85^{b}	4.44 ± 0.65^{a}	0.000
Sandy Texture	3.10 ± 0.90^{b}	3.23 ± 0.85^{b}	3.94 ± 1.09^{a}	0.000
Overall Liking	3.51 ± 0.61^{b}	3.33 ± 0.72^{b}	3.85 ± 0.92^{a}	0.000
Overall Accepting	3.54 ± 0.64^{b}	3.39 ± 0.68^{b}	4.06 ± 0.87^{a}	0.000

Note:
1. FBDC : Functional Butterfly Pea Drink with Collagen; FBDNC: Functional Butterfly Pea Drink Without Collagen
2. Hedonic Scale: 1-5 (Very Dislike – Very Like)

Discussion

The antioxidant activity of *emprit* ginger was the highest among the ingredients, at 317.36 ± 3.00 mg TE/100 ml (Table 1). However, despite its high individual antioxidant activity, the addition of ginger did not always lead to an increase in the overall antioxidant activity of the product. As shown in Figure 1, the combination of butterfly pea flower extract and red guava juice resulted in a significant increase in antioxidant activity in the final product, while the inclusion of emprit ginger extract tended to decrease the antioxidant response, as evidenced by the decrease in elevation in Figure 1 (b). This suggests that the antioxidant compounds in ginger do not consistently interact synergistically with other ingredients, as one might expect based on its individual antioxidant activity.The conclusions of the study may be presented in here.

A study by Singprecha et al. (2020) further supports this observation, showing that the interaction between ginger extract and ascorbic acid can result in an antagonistic effect. Ascorbic acid, when in liquid form, is easily oxidized, generating prooxidants that can react antagonistically with the phenolic compounds in ginger, such as gingerol and shogaol, thereby reducing their antioxidant activity. On the other hand, the interaction between butterfly pea flower extract and red guava juice appears to produce a synergistic effect, significantly enhancing the antioxidant activity of the product. This finding is consistent with the research of Tando et al. (2023), who also reported synergistic effects between butterfly pea and red guava in increasing the antioxidant activity of ice cream products. While the addition of red guava juice positively influenced the antioxidant activity, the effect was not as optimal as expected due to the degradation of anthocyanins caused by the ascorbic acid in the mixture, which negatively impacted antioxidant activity (Farr & Gusti, 2018). Despite this, the polyphenolic compounds in red guava juice contributed significantly to the total phenolic content, highlighting the complex interactions between ingredients that enhance antioxidant activity.

In terms of total phenolic content (TPC), red guava juice exhibited the highest concentration among the materials, with a total TPC of 411.677 ± 4.35 mg GAE/L (Table 1). Figure 2 further illustrates that the addition of red guava juice, particularly in combination with butterfly pea flower extract, resulted in the highest TPC in the product. Although the optimal phenolic content tended to decrease due to heat exposure during pasteurization (77°C), the combination of red guava juice and other ingredients showed a synergistic effect, boosting the TPC of the final product.

Research by Diep et al. (2020) suggests that the presence of polyphenol compounds can enhance the utilization of vitamin C, which may explain the observed increase in TPC when red guava juice is combined with butterfly pea flower extract. Red guava has been reported to contain around 57 identified phenolic compounds, including phenolic acids, tannins, flavonoids, gallic acid, catechins, and proanthocyanidins (Castaneda et al., 2023). The synergistic effect observed in the product is linked to the heterogeneity of polyphenolic compounds in red guava juice, which tends to increase total phenolic content (Singprecha et al., 2020). However, further research is needed to fully understand the underlying mechanisms of these interactions. Additionally, the addition of butterfly pea flower extract also had a positive effect on increasing TPC, as the pectin content in red guava helps to stabilize anthocyanins (Zhao et al., 2021). In contrast, ginger extract did not show a significant effect on TPC. Although ginger contains phenolic compounds such as gingerol and shogaol, the interaction with ascorbic acid appeared to have an antagonistic effect, reducing the effectiveness of antioxidants in the mixture (Singprecha et al., 2020; Colon & Nerín, 2016).

The formulation of each ingredient plays a crucial role in determining both antioxidant activity and TPC of the product. The balance of each ingredient's proportion significantly influences the chemical reactions that occur during formulation. As illustrated in Figure 3, the optimum formula for the product was achieved with a ratio of 50% butterfly pea flower extract, 30% red guava juice, 15% emprit ginger extract, and 5% collagen hydrolysate. Although an increase in total phenolic content was observed, it was not always accompanied by a proportional increase in antioxidant activity. This indicates that total phenolics, while useful as an indicator of antioxidant potential, are not the sole contributors to antioxidant activity. Non-phenolic antioxidants also play an important role in the overall antioxidant response. This observation is supported by the research of Singprecha et al. (2019), which highlights the effects of interactions between non-phenolic compounds and ascorbic acid on the antioxidant activity of the product. Furthermore, the presence of collagen hydrolysate enhances antioxidant stability due to the presence of hydrophobic amino acid residues, particularly proline, which contain aliphatic hydrocarbon side chains that can stabilize the interaction between peptides and free radicals (Deng et al., 2023). This aligns with the findings of Leon-Lopez (2020), who showed that collagen addition increases the bioavailability and nutritional value of products, particularly enhancing antioxidants and proteins.

This study was then followed by organoleptic testing through hedonic testing on 100 untrained panelists to evaluate the overall level of product acceptance.This study involved organoleptic testing through hedonic evaluation with 100 untrained panelists to assess overall product acceptance. The ANOVA test results indicate that significant differences were observed for the ginger aroma, ginger flavor, viscosity, clarity, and sandy texture attributes, while no significant differences were found for fishy odor, synthetic flavor, fruity flavor, sweetness, and sourness.

For ginger aroma, FBDC demonstrated the highest preference (3.66), followed by FBDNC (3.50), and the commercial product (3.21), suggesting that panelists preferred the ginger aroma in FBDC. The addition of collagen hydrolysate likely influenced this preference, enhancing the aroma as collagen proteins are known to bind volatile and flavor compounds (Wang et al., 2022). Fishy odor did not show significant differences across the samples ($p>0.05$), likely due to the masking effect of ginger extract and red guava, which suppressed the fishy odor from the collagen hydrolysate (Biewirth et al., 2015). Ginger flavor exhibited significant differences, with the commercial product rated highest (3.36), despite not containing ginger, suggesting panelists' aversion to the strong ginger flavor in FBDC (3.00) and FBDNC (2.77), potentially due to the high concentration of ginger extract (20%) contributing to an intense, less preferred spicy taste (Marsigit et al., 2019).

For attributes showing no significant differences, the synthetic flavor was similarly perceived across all samples ($p>0.05$), likely due to stevia's aftertaste, which can be perceived as artificial (Bhardwaj et al., 2020). Fruity flavor also showed no significant preference difference ($p > 0.05$), with panelists finding the fruity flavors from red guava (FBDC and FBDNC) and peach (commercial product) equally refreshing. Additionally, sweetness and sourness were comparable across all samples ($p>0.05$), suggesting that stevia provided similar sweetness and that the more pronounced sourness in the commercial product did not affect preferences.

Significant differences were observed for viscosity, with the commercial product being preferred (4.06), suggesting a preference for lower viscosity. FBDC (3.40) and FBDNC (3.50) had higher viscosity, likely due to fiber, pectin, and collagen, which increase viscosity (Rigoto et al., 2018). Collagen hydrolysate is also known to increase viscosity, albeit to a lesser extent than native collagen (León-López, 2020). Clarity also showed significant differences, with the commercial product rated highest (4.44), likely due to lower dissolved solids and fewer suspended particulates. Sandy texture also exhibited significant differences, with the commercial product preferred (3.94), while FBDC (3.10) and FBDNC (3.23) were less favored, likely due to larger particle sizes in these two samples, which are perceived as sandy (Breen et al., 2019).

Overall, FBDC received moderate acceptance, with an average preference score of 3.51 ("quite like") and an acceptance score of 3.54 ("quite like"). These findings suggest that FBDC was generally well accepted, particularly with respect to attributes such as ginger aroma, fishy odor, synthetic taste, fruity flavor, sweetness, and sourness. However, factors such as the strong ginger flavor, higher viscosity, reduced clarity, and sandy texture contributed to lower preference scores when compared to the commercial product, which scored higher in these attributes.

CONCLUSION

Based on this research, there was several key findings concerning the development of collagen functional beverages derived from Butterfly Pea Flower and Red Guava. Initially, *emprit* ginger extract exhibited the highest antioxidant activity, followed by butterfly pea flower extract and red guava juice. However, the combination of butterfly pea flower extract and red guava juice exhibited a substantial synergistic effect in enhancing the antioxidant activity of the product. Conversely, the incorporation of emprit ginger extract tended to diminish the antioxidant response. Secondly, red guava juice exhibited the highest total phenolic content and contributed significantly to the augmentation of the product's total phenolic content, particularly when combined with telang flower extract. The optimal formula of the product was achieved with a ratio of 50% telang flower extract, 30% red guava juice, 15% emprit ginger extract, and 5% collagen hydrolysate.

While this study makes a significant contribution to the field, it is imperative to acknowledge its limitations. The study's methodological limitations encompass the utilization of untrained panelists in sensory evaluation and the constraints in data availability concerning specific interactions between phenolic and non-phenolic compounds in products. Moreover, the present study was constrained by its focus on a specific combination of raw materials, precluding an investigation into alternative raw materials. In light of these limitations, future research endeavors may focus on the utilization of trained panelists for more precise sensory evaluation, further exploration of the mechanism of compound interactions in the product, and investigation of alternative raw material combinations in the development of collagen functional beverage.

Acknowledgements: All the research process can't be done without the support from our supervisor, our paraents, friends, food nutrition laboratory staff, integrated laboratory staffs, and all family from magister of agricultural product technology, University of Brawijaya 2023.

Funding: All the funding was supported by Lembaga Pengelola Dana Pendidikan Republik Indonesia.

Competing Interests: The authors declare that there are no competing interests.

REFERENCES

Aron, N. (2019). Functional Beverages in Health Promotion, Sport, and Disease Prevention: An Overview. *Sports and Energy Drinks*. https://doi.org/10.1016/B978-0-12-815851-7.00009-7

Bilek, S., & Bayram, S. (2015). Fruit juice drink production containing hydrolyzed collagen. *Journal of Functional Foods*, *14*, 562–569. https://doi.org/10.1016/J.JFF.2015.02.024

Carvalho, F., Lahlou, R. A., Pires, P., Salgado, M., & Silva, L. (2023). Natural Functional Beverages as an Approach to Manage Diabetes. *International Journal of Molecular Sciences*, *24*. https://doi.org/10.3390/ijms242316977

Bhardwaj, V., Singh, R., Singh, P., Purohit, R., & Kumar, S. (2020). Elimination of bitter-off taste of stevioside through structure modification and computational interventions. Journal of Theoretical Biology, 486, 110094.

Bierwirth, J. E., Oftedal, K. N., Civille, G. V., & Fahey, J. W. (2015). Flavor misattribution: A novel approach to improving compliance and blinding in food-based clinical interventions. NFS Journal, 1, 24–30. https://doi.org/10.1016/j.nfs.2015.07.001

Breen, S. P., Etter, N. M., Ziegler, G. R., & Hayes, J. E. (2019). Oral somatosensatory acuity is related to particle size perception in chocolate. Scientific Reports, 9(1), 1–10. https://doi.org/10.1038/s41598-019-43944-7

Colon, M., & Nerín, C. (2016). Synergistic, antagonistic and additive interactions of green tea polyphenols. European Food Research and Technology, 242(2), 211–220. https://doi.org/10.1007/s00217-015-2532-9

Deng, G., Huang, K., Jiang, X., Wang, K., Song, Z., Su, Y., Li, C., Zhang, S., Wang, S., & Huang, Y. (2023). Developments for collagen hydrolysates as a multifunctional antioxidant in biomedical domains. Collagen and Leather, 5(1). https://doi.org/10.1186/s42825-023-00131-9

Diep, T., Pook, C., & Yoo, M. (2020). Phenolic and anthocyanin compounds and antioxidant activity of Tamarillo (Solanum betaceum Cav.). Antioxidants, 9(2), 1–20. https://doi.org/10.3390/antiox9020169

Diep, T., Pook, C., & Yoo, M. (2020). Phenolic and anthocyanin compounds and antioxidant activity of Tamarillo (Solanum betaceum Cav.). Antioxidants, 9(2), 1–20. https://doi.org/10.3390/antiox9020169

Durán-Castañeda, A. C., Cardenas-Castro, A. P., Pérez-Jiménez, J., Pérez-Carvajal, A. M., Sánchez-Burgos, J. A., Mateos, R., & Sáyago-Ayerdi, S. G. (2023). Bioaccessibility of phenolic compounds in Psidium guajava L. varieties and P. friedrichsthalianum Nied. after gastrointestinal digestion. Food Chemistry, 400(August 2022).

Duy, N. Q., Nguyen, T. M. H., Lam, T. D., Pham, T. N., & Thanh, T. T. (2020, March). Extraction and Determination of Antioxidant Activity of Vietnamese Butterfly Pea (Clitoria ternatia L.). In Materials Science Forum (Vol. 977, pp. 207-211). Trans Tech Publications Ltd**.**

Farr, J. E., & Monica Giusti, M. (2018). Investigating the interaction of ascorbic acid with anthocyanins and pyranoanthocyanins. Molecules, 23(4). https://doi.org/10.3390/molecules23040744

Gupta, A., Sanwal, N., Bareen, M., Barua, S., Sharma, N., Olatunji, O. J., Nirmal, N. P., & Sahu, J. (2023). Trends in functional beverages: Functional ingredients, processing technologies, stability, health benefits, and consumer perspective. *Food Research International*, *170*, 113046. https://doi.org/10.1016/j.foodres.2023.113046

León-López, A., Pérez-Marroquín, X. A., Campos-Lozada, G., Campos-Montiel, R. G., & Aguirre-Álvarez, G. (2020). Characterization of whey-based fermented beverages supplemented with hydrolyzed collagen: Antioxidant activity and bioavailability. Foods, 9(8). https://doi.org/10.3390/foods9081106

Marsigit, W., Susanti, L., & Marzalena, L. (2019). Effect Of Red Ginger Extract (Zingiber Officinale Var Rubrum) On Chemical And Organoleptics Quality Of Ambon Curup Banana Wet "Sale." Jurnal Agroindustri, 9(1), 28–36.

Nazir, M., Arif, S., Khan, R. S., Nazir, W., Khalid, N., & Maqsood, S. (2019). Opportunities and challenges for functional and medicinal beverages: Current and future trends. *Trends in Food Science & Technology*. https://doi.org/10.1016/J.TIFS.2019.04.011

Singleton, V. L., Orthofer, R., & Lamuela-Raventós, R. M. (1999). [14] Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. In Methods in enzymology (Vol. 299, pp. 152-178). Academic press.

Singprecha, A., Yarovaya, L., & Khunkitti, W. (2020). The interaction effect of ginger extract and ascorbic acid on antioxidant activity. Songklanakarin Journal of Science and Technology, 42(4), 850–857. https://doi.org/10.14456/sjst-psu.2020.109

Tando, A. A., Puryana, I. G. P. S., & Antarini, A. A. N. (2023). Pengaruh Penambahan Jus Jambu Biji Merah (Psidium Guajava Linn) Dan Ekstrak Bunga Telang (Clitoria Ternatea L.) Terhadap Karakteristik Es Krim. 12(4), 240–247.

Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L., & Byrne, D. H. (2006). Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. Journal of food composition and analysis, 19(6-7), 669-675.

Wang, X., Le, B., Zhang, N., Bak, K. H., Zhang, Y., & Fu, Y. (2023). Off-flavour compounds in collagen peptides from fish: Formation, detection and removal. International Journal of Food Science and Technology, 58(3), 1543–1563. https://doi.org/10.1111/ijfs.15962

Yilmaz-Akyuz, E., Üstün-Aytekin, Ö., Bayram, B., & Tutar, Y. (2019). Nutrients, Bioactive Compounds, and Health Benefits of Functional and Medicinal Beverages. *Nutrients in Beverages*. https://doi.org/10.1016/B978-0-12-816842-4.00006-X

Zhao, L., Pan, F., Mehmood, A., Zhang, H., Ur Rehman, A., Li, J., Hao, S., & Wang, C. (2021). Improved color stability of anthocyanins in the presence of ascorbic acid with the combination of rosmarinic acid and xanthan gum. Food Chemistry, 351(February), 129317. https://doi.org/10.1016/j.foodchem.2021.129317