Journal Global of Food Technology
ISSN 3163-4745
61
Vol. 1, No. 1,March 31,2026, pp. 61-63

Effect of Ginger (Zingiber officinale) Extract Incorporation on the Quality, Antioxidant Capacity, and Shelf Life of Ready-to-Drink Herbal Beverages

Lina Marlina[1,*], Andika Saputra[1,], Siti Rahmawati[2,], Bagus Prakoso[2]

[1]*Department of Food Science and Technology, IPB University, Indonesia;*
[2]*Department of Food Technology, Universitas Diponegoro, Indonesia*
(Received: January 04, 2026; Revised: January 11, 2026; Accepted: February, 2026; Available online: March 31, 2026)

Abstract

Consumer demand for natural, health-promoting beverages has increased substantially in recent years, driving innovation in functional drink development. Ginger (Zingiber officinale) is widely recognized for its rich content of bioactive compounds, including gingerols, shogaols, paradols, and phenolic compounds that exhibit antioxidant, antimicrobial, and anti-inflammatory properties. This study evaluated the effects of ginger extract incorporation on the physicochemical characteristics, antioxidant capacity, microbial stability, and sensory acceptance of ready-to-drink (RTD) herbal beverages. Four formulations containing different concentrations of ginger extract (0%, 2%, 4%, and 6%) were prepared and analyzed for pH, total soluble solids, total phenolic content, total flavonoid content, and antioxidant activity, with shelf-life stability assessed during 90 days of storage.
Results indicated that increasing ginger extract concentration significantly enhanced total phenolic content, total flavonoid content, and antioxidant activity ($p < 0.05$), with the highest antioxidant activity observed in beverages containing 6% ginger extract (84.7% DPPH inhibition). Ginger extract also improved microbial stability during storage. Sensory evaluation revealed that beverages containing 4% ginger extract achieved the highest overall acceptability score, supporting ginger extract as an effective natural functional ingredient for clean-label beverage development.

Keywords: Ginger extract, functional beverage, antioxidant activity, microbial stability, herbal drink, clean-label products

1. Introduction

The global beverage industry has experienced a significant transformation driven by increasing consumer awareness regarding health, nutrition, and wellness, leading to rapid growth in the market for herbal beverages and functional drinks [1].

Among various medicinal plants, ginger (Zingiber officinale) has been extensively used in traditional medicine and food applications for centuries. Ginger rhizomes contain numerous biologically active compounds, including gingerols, shogaols, paradols, zingerone, flavonoids, and phenolic acids [3].

Scientific evidence has demonstrated that ginger exhibits antioxidant, antimicrobial, anti-inflammatory, antiemetic, antidiabetic, antihypertensive, and immunomodulatory properties, primarily attributed to its high concentrations of phenolic and flavonoid compounds [4, 5].

Therefore, the objectives of this study were to evaluate the effects of ginger extract incorporation on the physicochemical properties, antioxidant capacity, microbial stability, and sensory characteristics of ready-to-drink herbal beverages and to determine the optimal concentration for product development.

2. Literature Review

2.1. Bioactive Compounds in Ginger Rhizome

Gingerols, shogaols, and paradols are the principal pungent constituents of ginger, with 6-gingerol considered the most biologically active compound responsible for many of its therapeutic effects [3, 10].

2.2. Antioxidant and Antimicrobial Mechanisms of Ginger

Ginger-derived phenolic compounds neutralize reactive oxygen species through hydrogen donation and metal chelation, while simultaneously disrupting microbial cell membranes and inhibiting enzymatic activity in spoilage organisms [11, 13].

Journal GLOBAL OF FOOD TECHNOLOGY
Vol. 1, No. 1,March 31,2026, pp. 61-63

2.3. Clean-Label Beverage Development

Clean-label products are characterized by simple ingredient lists, minimal processing, and the absence of artificial additives, positioning natural plant extracts such as ginger as multifunctional ingredients combining flavor, antioxidant, and preservative functions [6, 19].

3. Methodology

3.1. Experimental Design

A Completely Randomized Design (CRD) was employed with four treatments: G0 (0%), G1 (2%), G2 (4%), and G3 (6%) ginger extract. Each treatment was prepared in triplicate.

3.2. Preparation of Ginger Extract and Beverage Formulation

Fresh ginger rhizomes were washed, peeled, sliced, dried at 50°C for 12 hours, and milled into powder. Extraction was conducted using hot-water extraction at 80°C for 30 minutes with a solid-to-solvent ratio of 1:10 (w/v), filtered, and stored at 4°C. Beverages were formulated with water, ginger extract, honey (8%), and lemon juice (2%), then homogenized and pasteurized at 85°C for 15 minutes.

3.3. Physicochemical, Phenolic, Flavonoid, and Antioxidant Analyses

pH and total soluble solids (TSS) were measured using a digital pH meter and refractometer, respectively. Total phenolic content (TPC) was determined using the Folin–Ciocalteu method (mg GAE/100 mL), total flavonoid content (TFC) using the aluminum chloride colorimetric method (mg QE/100 mL), and antioxidant activity using the DPPH radical scavenging assay [7, 8].

3.4. Microbiological and Sensory Analysis

Microbial stability was assessed through total plate count and yeast and mold count over 90 days of storage. Thirty semi-trained panelists evaluated color, aroma, taste, aftertaste, and overall acceptability using a 9-point hedonic scale. Data were analyzed using one-way ANOVA followed by DMRT at $p < 0.05$.

4. Results and Discussion

4.1. Physicochemical Properties

The incorporation of ginger extract slightly reduced pH values while increasing soluble solids content.

Table 1. pH and total soluble solids of beverage samples.

Treatment	pH	TSS (°Brix)
G0	4.21	8.4
G1	4.15	8.5
G2	4.08	8.6
G3	4.01	8.7

Source: Physicochemical analysis of beverage samples.

4.2. Phenolic Content and Antioxidant Activity

TPC, TFC, and antioxidant activity increased significantly with increasing ginger extract concentration, with strong positive correlations observed among these parameters.

Table 2. Phenolic, flavonoid content, and antioxidant activity of beverage samples.

Treatment	TPC (mg GAE/100mL)	TFC (mg QE/100mL)	DPPH (%)
G0	28.6	8.7	18.9
G1	72.4	21.4	48.6

Vol. 1, No. 1,March 31,2026, pp. 61-63

G2	115.3	34.6	69.2
G3	148.7	46.3	84.7

Source: Phenolic, flavonoid, and antioxidant analysis of beverage samples.

4.3. Microbial Stability

The antimicrobial activity of ginger significantly inhibited microbial growth during storage, with G3 exhibiting the lowest total plate count (2.9 log CFU/mL) after 90 days compared to 4.9 log CFU/mL in the control.

4.4. Sensory Evaluation

Beverages containing 4% ginger extract (G2) achieved the highest consumer acceptance across all sensory attributes evaluated.

Table 3. Sensory scores of beverage samples on a nine-point hedonic scale.

Attribute	G0	G1	G2	G3
Color	7.6	8.0	8.4	7.9
Aroma	7.5	8.2	8.6	8.1
Taste	7.4	8.1	8.7	7.6
Overall Acceptability	7.4	8.2	8.8	7.7

Values represent mean scores from 30 semi-trained panelists.

5. Conclusion

The incorporation of ginger (Zingiber officinale) extract significantly improved the physicochemical properties, antioxidant capacity, microbial stability, and sensory quality of ready-to-drink herbal beverages. The beverage containing 6% ginger extract exhibited the highest antioxidant activity and microbial stability; however, sensory evaluation identified the 4% formulation as most preferred, representing the optimal balance between functional performance and consumer acceptance for commercial production.

References

[1] T. Ahmad, M. Cawood, and Q. Iqbal, "Functional beverages: current trends and future perspectives," Food Biosci., vol. 56, p. 103320, 2023.

[2] A. M. Ali, N. A. Ismail, and F. Othman, "Herbal beverages and consumer health," Foods, vol. 10, no. 11, p. 2758, 2021.

[3] S. K. Al-Matani, N. A. Al-Wabel, and J. Hussain, "Bioactive compounds and antioxidant activities of ginger," Molecules, vol. 27, no. 15, p. 4789, 2022.

[4] A. Amalraj, A. Pius, and S. Gopi, "Biological activities of ginger and its phytochemicals," Nutrients, vol. 15, no. 4, p. 982, 2023.

[5] G. E. Batiha, L. M. Alkazmi, and L. G. Wasef, "Pharmacological properties of ginger," Biomed. Pharmacother., vol. 150, p. 113014, 2022.

[6] M. A. Hossain, H. C. Park, and J. K. Kim, "Ginger as a natural preservative in food products," LWT, vol. 162, p. 113481, 2022.

[7] A. H. El-Ghorab, M. Nauman, and F. M. Anjum, "Phenolic composition of ginger extracts," Antioxidants, vol. 10, no. 8, p. 1281, 2021.

[8] I. Gulcin, "Antioxidant mechanisms of plant phenolics," Antioxidants, vol. 12, no. 3, p. 541, 2023.

[9] A. K. Das, P. K. Nanda, and S. Bandyopadhyay, "Natural antioxidants in beverage systems," Food Chem., vol. 450, p. 139407, 2024.

[10] A. Ghasemzadeh, H. Z. E. Jaafar, and A. Rahmat, "Flavonoids and antioxidant capacity in herbal beverages," Food Res. Int., vol. 169, p. 112840, 2023.

[11] M. H. Shahrajabian, W. Sun, and Q. Cheng, "Ginger cultivation and industrial applications," Plants, vol. 10, no. 6, p. 1225, 2021.

[12] C. Zhao, F. Wang, and Y. Lian, "Bioactive compounds and beverage stability," Food Chem., vol. 414, p. 135705, 2023.

[13] N. Kumar, P. Goel, and R. Singh, "Antimicrobial properties of ginger bioactives," Food Biosci., vol. 53, p. 102612, 2023.

[14] S. Yadav, A. Malik, and P. Sharma, "Consumer acceptance of functional beverages," Food Qual. Prefer., vol. 116, p. 105088, 2024.

[15] J. M. Zingg, S. T. Hasan, and M. Meydani, "Functional ingredients for clean-label foods," Trends Food Sci. Technol., vol. 126, pp. 250–266, 2022.