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Effect of ground ginger (*Zingiber officinale*) on the phytochemical composition of stored cowpea (*Vigna unguiculata*) during storage

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Abstract
This study evaluated the effect of ground ginger (*Zingiber officinale*) on the phytochemical composition of stored cowpea (*Vigna unguiculata*). Cowpea grains were obtained from three major markets in Port Harcourt, Rivers State, while fresh ginger rhizomes were processed into powder. The ginger powder was applied at 5 g, 10 g, 15 g and 20 g per 100 g of cowpea, with mancozeb-treated and untreated cowpea serving as the positive and negative controls, respectively. The experiment was arranged in a Completely Randomized Design (CRD) with three replicates and the treated samples were stored for three months. Phytochemical parameters, including polyphenols, tannins, saponins and oxalates, were determined using standard analytical methods. Data obtained were analysed using analysis of variance (ANOVA), and means were separated using Duncan's Multiple Range Test at 5% level of significance. The results showed that ginger treatment significantly ($p < 0.05$) influenced the phytochemical composition of stored cowpea throughout the storage period. Higher concentrations of ginger, particularly 15 g and 20 g, retained higher levels of beneficial phytochemicals compared with the untreated control. The study therefore showed that ground ginger can serve as an effective natural preservative for maintaining the phytochemical quality of stored cowpea during storage.

Keywords: *Zingiber officinale*, *Vigna unguiculata*, phytochemicals, bio-preservation, storage

Introduction

Cowpea (*Vigna unguiculata*) is an important grain legume widely cultivated and consumed in sub-Saharan Africa. It is a rich source of protein, carbohydrates, dietary fiber, vitamins and minerals, making it an affordable food for many households, particularly in developing countries. In Nigeria, cowpea is an important staple crop that contributes to food security and provides income for farmers and traders (Boukar *et al*., 2019; FAOSTAT, 2023) [2]. However, preserving its quality during storage remains a major challenge due to the warm and humid conditions that favour spoilage.

During storage, cowpea grains are easily contaminated by microorganisms, especially fungi, which reduce their quality and shelf life. Fungal growth may also alter the chemical composition of the grains, including the phytochemicals that contribute to their nutritional and functional value. In addition, some storage fungi are capable of producing harmful toxins that pose health risks to consumers if contaminated grains are consumed (Pitt & Hocking, 2022) [8]. These problems have increased the need for effective and safe methods of preserving stored cowpea.

Synthetic preservatives and fungicides have long been used to reduce post-harvest losses in stored grains. Although they are effective, their repeated use has raised concerns because of chemical residues in food, environmental contamination and the possible development of resistant microorganisms (Nicolopoulou-Stamati *et al*., 2016; Sharma *et al*., 2020) [6, 11]. As a result, there is growing interest in natural alternatives that are safe, affordable and environmentally friendly.

Botanical plants have received considerable attention as natural preservatives because they contain bioactive compounds with antioxidant and antimicrobial properties. Ginger (*Zingiber officinale*) is one of the most widely used medicinal plants and is known to contain compounds such as gingerols, shogaols and other phenolic substances that help protect food from deterioration (Semwal *et al*., 2015; Mao *et al*., 2019) [5, 9]. Besides its medicinal importance, ginger has been reported to improve the storage quality of several food products, making it a promising natural preservative for stored grains.

Phytochemicals, including polyphenols, tannins and saponins, are naturally occurring compounds that contribute to the nutritional quality and health benefits of foods. However, the levels of these compounds may change during storage depending on storage conditions and the preservation method used. Therefore, assessing the phytochemical composition of stored cowpea is important in determining the effectiveness of natural preservatives in maintaining grain quality (Shahidi & Ambigaipalan, 2015) [10].

Although the preservative properties of ginger have been reported in different food products, there is limited information on the effect of ground ginger on the phytochemical composition of stored cowpea under tropical storage conditions. This study was therefore carried out to evaluate the effect of ground ginger (*Zingiber officinale*) on the phytochemical composition of stored cowpea (*Vigna unguiculata*) during storage.

Materials and Methods

Study Area and Sample Collection

The study was carried out in the Plant Science and Biotechnology Laboratory, Department of Plant Science and Biotechnology, Rivers State University, Port Harcourt, Nigeria. Clean, mature cowpea (*Vigna unguiculata*) grains were purchased from three major markets (Oil Mill, Creek Road and Mile One markets) in Port Harcourt, Rivers State. Fresh ginger (*Zingiber officinale*) rhizomes were also obtained from Oil Mill markets. Foreign materials, damaged grains and other impurities were removed manually before the experiment.

Preparation of Ginger Powder
The ginger rhizomes were washed thoroughly with clean water to remove adhering soil particles and debris. They were sliced into small pieces and air-dried under laboratory conditions until a constant weight was obtained. The dried ginger slices were milled into a fine powder using an electric grinder and stored in clean, airtight containers until required for the experiment.

Experimental Design and Treatment
The experiment was arranged in a Completely Randomized Design (CRD) with three replicates. One hundred grams (100g) of clean cowpea grains were weighed into sterile plastic containers and treated with 5g, 10g, 15g and 20g of ginger powder. Cowpea treated with mancozeb served as the positive control, while untreated cowpea served as the negative control. The treated samples were thoroughly mixed to ensure uniform distribution of the treatments and stored under ambient laboratory conditions for three months.

Phytochemical Analysis
Phytochemical analyses were carried out before storage and at monthly intervals during the three-month storage period. The concentrations of polyphenols, tannins, saponins and oxalates were determined using standard analytical procedures described by Onwuka (2005) [7] and AOAC (2010) [1]. All analyses were performed in triplicate, and the mean values were recorded.

Statistical Analysis
Data obtained from the study were subjected to one-way analysis of variance (ANOVA) using IBM SPSS Statistics. Where significant differences occurred among treatment means, Duncan's Multiple Range Test (DMRT) was used for mean separation at a 5% level of significance ($p < 0.05$).

Results
The phytochemical composition of stored cowpea after one, two and three months of treatment with ground ginger is presented in Tables 1, 2 and 3.

After one month of storage, significant differences ($p < 0.05$) were observed among the treatments for all the phytochemical parameters analysed. Polyphenol content ranged from 9.45% in the 5g ginger treatment to 13.05% in the 20g fungicide treatment, while the untreated control recorded 9.70%. Flavonoid content varied from 11.50% to 12.75%, with the highest value recorded in the 20g ginger treatment. Lignan content was also highest in the 20g ginger treatment (16.50%) and lowest in the untreated control (12.61%). Tannin values increased with treatment concentration and reached 0.07% in the 20g ginger treatment, whereas oxalate remained low across all treatments (0.02-0.05%).

After two months of storage, ginger-treated samples continued to retain higher levels of beneficial phytochemicals than the untreated control. Polyphenol content ranged from 9.85% in the control to 12.50% in the 20g fungicide treatment and 12.05% in the 20g ginger treatment. Flavonoid and lignan contents were highest in the 20g ginger treatment, recording 15.00% and 18.05%, respectively. Saponin values ranged from 0.05% to 0.09%, while oxalate remained low in all treatments. Significant differences ($p < 0.05$) were observed among treatments for all the phytochemical parameters measured.

At the end of the three-month storage period, treatment with ground ginger significantly ($p < 0.05$) influenced the phytochemical composition of the stored cowpea. The highest polyphenol (12.90%), flavonoid (16.80%) and carotenoid (12.70%) contents were recorded in the 20g ginger treatment, whereas the untreated control had lower values of these phytochemicals. Lignan content also remained highest in the 20g ginger treatment. Although slight variations were observed in phytate, oxalate, saponin and tannin contents during storage, their values remained relatively low across all treatments. Overall, higher concentrations of ground ginger maintained better phytochemical quality than the untreated control throughout the storage period.

Table 1: Effect of Ground Ginger (*Zingiber officinale*) on the Phytochemical Composition of Stored Cowpea (*Vigna unguiculata*) After One Month of Storage (%)

Parameters Treatment	Before Treatment	One Month After Treatment								Control
		5g F	5g G	10g F	10g G	15g F	15g G	20g F	20g G	
Phytate	0.03±0.00	0.04±0.00^{b}	0.04±0.01^{b}	0.04±0.00^{b}	0.04±0.00^{b}	0.06±0.00^{a}	0.04±0.00^{b}	0.07±0.00^{a}	0.04±0.00^{b}	0.04±0.00^{b}
Oxalate	0.07±0.01	0.03±0.00^{c}	0.02±0.00^{d}	0.02±0.00^{d}	0.02±0.00^{d}	0.04±0.00^{b}	0.02±0.00^{d}	0.05±0.00^{a}	0.02±0.00^{d}	0.03±0.00^{c}
Saponin	0.03±0.00	0.06±0.00^{c}	0.03±0.00^{f}	0.07±0.00^{b}	0.03±0.00^{f}	0.08±0.00^{a}	0.03±0.00^{f}	0.05±0.00^{d}	0.04±0.00^{e}	0.05±0.00^{e}
Tannin	0.02±0.00	0.02±0.00^{g}	0.05±0.00^{c}	0.02±0.00^{fg}	0.05±0.00^{c}	0.03±0.00^{ef}	0.06±0.00^{b}	0.04±0.00^{d}	0.07±0.00^{a}	0.04±0.00^{dc}
Carotenoid	10.57±0.01	9.05±0.00^{e}	11.45±0.07^{b}	9.05±0.00^{e}	10.20±0.00^{c}	10.35±0.21^{c}	12.04±0.00^{a}	10.25±0.07^{c}	11.57±0.01^{b}	9.28±0.02^{d}
Polyphenol	9.54±0.02	11.52±0.00^{e}	9.45±0.00^{g}	11.60±0.00^{d}	10.39±0.00^{i}	12.02±0.00^{c}	11.41±0.00^{f}	13.05±0.00^{a}	12.42±0.00^{b}	9.70±0.01^{h}
Flavonoid	11.04±0.00	12.23±0.00^{cd}	11.50±0.00^{e}	12.25±0.00^{c}	12.10±0.00^{d}	12.24±0.01^{c}	12.50±0.00^{b}	12.26±0.00^{c}	12.75±0.07^{a}	11.58±0.10^{e}
Lignans	16.00±0.00	14.20±0.00^{h}	15.02±0.00^{g}	15.30±0.00^{f}	15.50±0.00^{e}	16.03±0.01^{b}	15.70±0.00^{d}	15.90±0.00^{c}	16.50±0.00^{a}	12.61±0.00^{i}

Means with different superscripts within the same row are significant different ($P \leq 0.05$).

Table 2: Effect of Ground Ginger (*Zingiber officinale*) on the Phytochemical Composition of Stored Cowpea (*Vigna unguiculata*) After Two Months of Storage (%)

Parameters Treatment	Before Treatment	2 Month After Treatment								Control
		5g F	5g G	10g F	10g G	15g F	15g G	20g F	20g G	
Phytate	0.03±0.00	0.04±0.00^{d}	0.01±0.00^{f}	0.05±0.00^{c}	0.01±0.00^{f}	0.06±0.00^{b}	0.01±0.00^{f}	0.08±0.00^{a}	0.02±0.00^{e}	0.04±0.00^{d}
Oxalate	0.07±0.01	0.02±0.00^{d}	0.02±0.00^{d}	0.04±0.00^{bc}	0.02±0.00^{d}	0.04±0.00^{b}	0.02±0.00^{d}	0.05±0.00^{a}	0.02±0.00^{d}	0.03±0.00^{c}

Saponin	0.03±0.00	0.06±0.00^{de}	0.09±0.00^{a}	0.06±0.00^{cd}	0.08±0.00^{ab}	0.08±0.00^{bc}	0.06±0.00^{cd}	0.06±0.00^{dc}	0.06±0.00^{de}	0.05±0.00^{e}
Tannin	0.02±0.00	0.02±0.00^{b}	0.02±0.00^{b}	0.03±0.00^{b}	0.02±0.00^{b}	0.24±0.29^{b}	0.02±0.00^{b}	0.50±0.00^{a}	0.04±0.00^{b}	0.06±0.00^{b}
Carotenoid	10.57±0.01	9.50±0.00^{d}	9.56±0.00^{d}	9.56±0.00^{d}	9.83±0.00^{c}	10.60±0.00^{a}	10.50±0.00^{b}	10.55±0.00^{a}	10.60±0.00^{a}	10.30±0.00^{b}
Polyphenol	9.54±0.02	11.62±0.03^{e}	11.50±0.00^{f}	11.75±0.00^{d}	12.00±0.07^{b}	11.80±0.00^{cd}	11.86±0.00^{c}	12.50±0.00^{a}	12.05±0.00^{b}	9.85±0.00^{g}
Flavonoid	11.04±0.00	12.22±0.01^{h}	12.20±0.07^{h}	12.79±0.01^{f}	13.30±0.00^{e}	13.50±0.00^{d}	14.50±0.00^{b}	13.75±0.00^{c}	15.00±0.00^{a}	12.55±0.07^{g}
Lignans	16.00±0.00	14.45±0.07^{h}	15.40±0.00^{f}	15.15±0.07^{g}	16.20±0.00^{d}	16.05±0.00^{e}	16.80±0.00^{c}	17.50±0.00^{b}	18.05±0.00^{a}	13.20±0.00^{i}

Means with different superscripts within the same row are significant different ($P \leq 0.05$)

Table 3: Effect of Ground Ginger (*Zingiber officinale*) on the Phytochemical Composition of Stored Cowpea (*Vigna unguiculata*) After Three Months of Storage (%)

Parameters Treatment	Before Treatment	3 Month After Treatment								Control
		5g F	5g G	10g F	10g G	15g F	15g G	20g F	20g G	
Phytate	0.03±0.00	0.02±0.00^{d}	0.02±0.00^{d}	0.04±0.00^{c}	0.02±0.00^{d}	0.04±0.00^{b}	0.02±0.00^{d}	0.06±0.00^{a}	0.02±0.00^{d}	0.03±0.00^{cd}
Oxalate	0.07±0.01	0.02±0.00^{a}	0.03±0.00^{a}	0.02±0.00^{a}	0.03±0.00^{a}	0.02±0.00^{a}	0.03±0.00^{a}	0.03±0.00^{a}	0.03±0.00^{a}	0.02±0.00^{a}
Saponin	0.03±0.00	0.05±0.00^{ab}	0.00±0.00^{d}	0.05±0.00^{ab}	0.05±0.00^{ab}	0.05±0.00^{ab}	0.04±0.00^{c}	0.06±0.00^{a}	0.01±0.00^{d}	0.04±0.00^{bc}
Tannin	0.02±0.00	0.04±0.00^{c}	0.04±0.00^{c}	0.04±0.00^{bc}	0.05±0.00^{ab}	0.06±0.00^{a}	0.04±0.00^{c}	0.05±0.00^{ab}	0.03±0.00^{d}	0.05±0.00^{ab}
Carotenoid	10.57±0.01	8.79±0.29^{h}	9.50±0.00^{g}	9.75±0.00^{f}	10.20±0.00^{e}	10.65±0.00^{d}	11.80±0.00^{b}	11.50±0.00^{c}	12.70±0.00^{a}	10.25±0.00^{e}
Polyphenol	9.54±0.02	11.75±0.00^{f}	11.50±0.00^{h}	11.85±0.00^{e}	11.40±0.00^{i}	11.96±0.00^{d}	12.80±0.00^{b}	12.18±0.09^{c}	12.90±0.00^{a}	9.90±0.07^{j}
Flavonoid	11.04±0.00	12.23±0.00^{f}	13.50±0.00^{d}	12.57±0.01^{e}	14.40±0.00^{c}	13.50±0.00^{d}	15.70±0.00b	13.42±0.24d	16.80±0.00a	12.52±0.10e
Lignans	16.00±0.00	15.50±0.00^{e}	15.50±0.00^{f}	15.76±0.02^{e}	15.60±0.00^{e}	16.05±0.00^{d}	16.70±0.00^{b}	16.38±0.17^{c}	17.80±0.00^{a}	13.50±0.00^{f}

Means with different superscripts within the same row are significant different ($P \leq 0.05$).

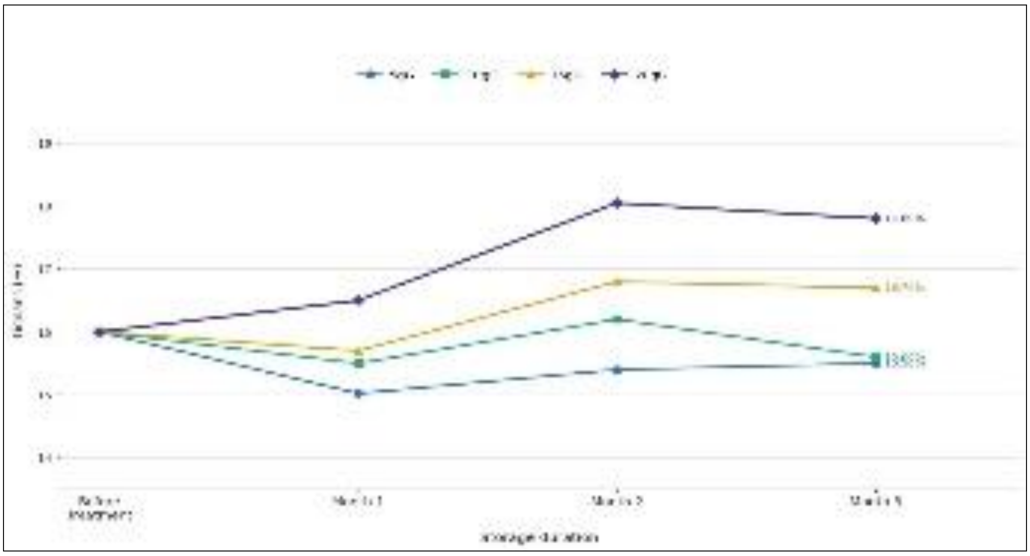

Fig 1: Effect of Ginger Powder Concentrations on Lignans Content of Stored Cowpea Over 3 Months

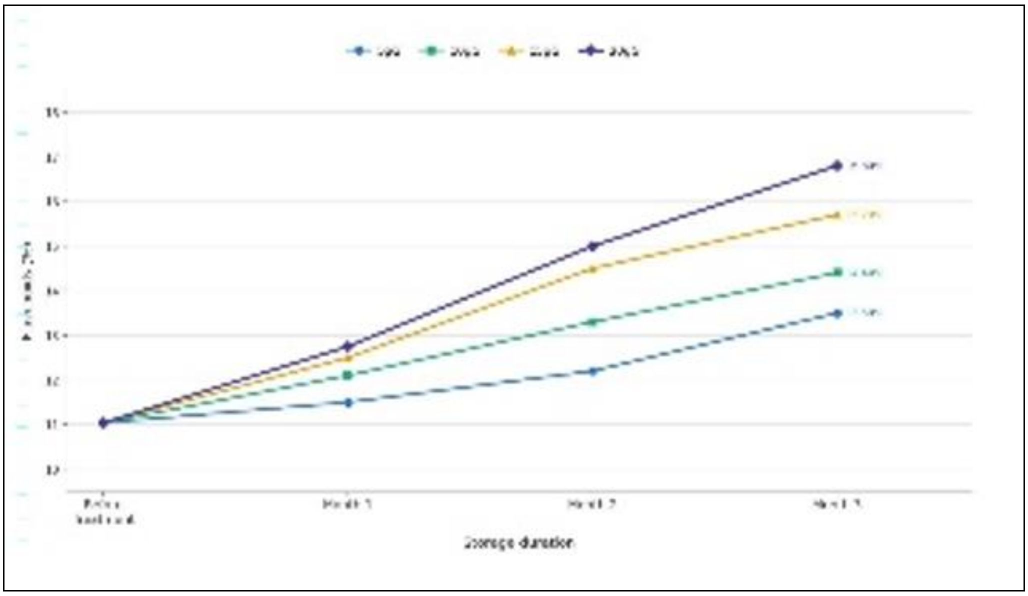

Fig 2: Effect of Ginger Powder Concentrations on Flavonoids Content of Stored Cowpea Over 3 Months

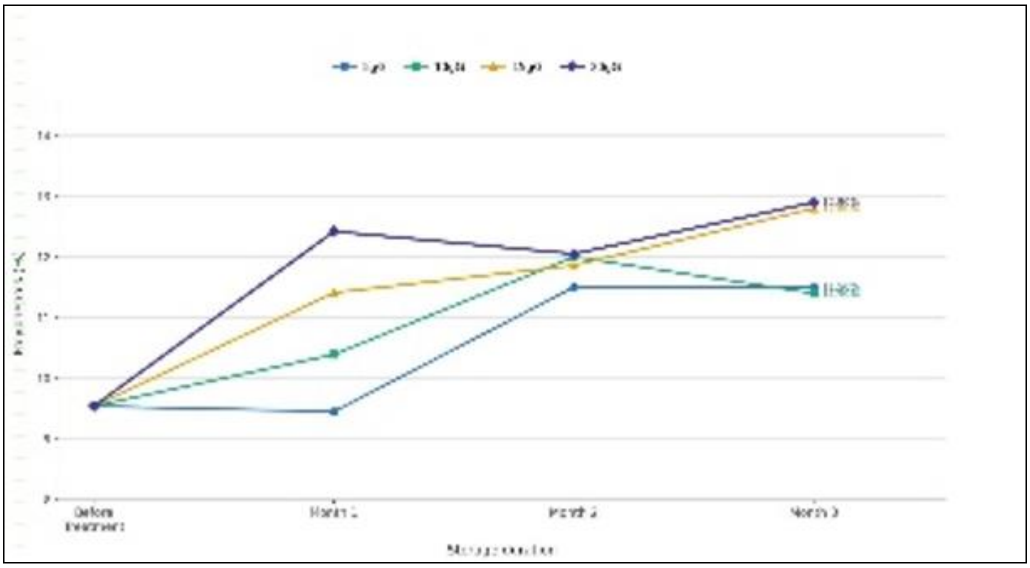

Fig 3: Effect of Ginger Powder Concentrations on Polyphenols Content of Stored Cowpea Over 3 Months

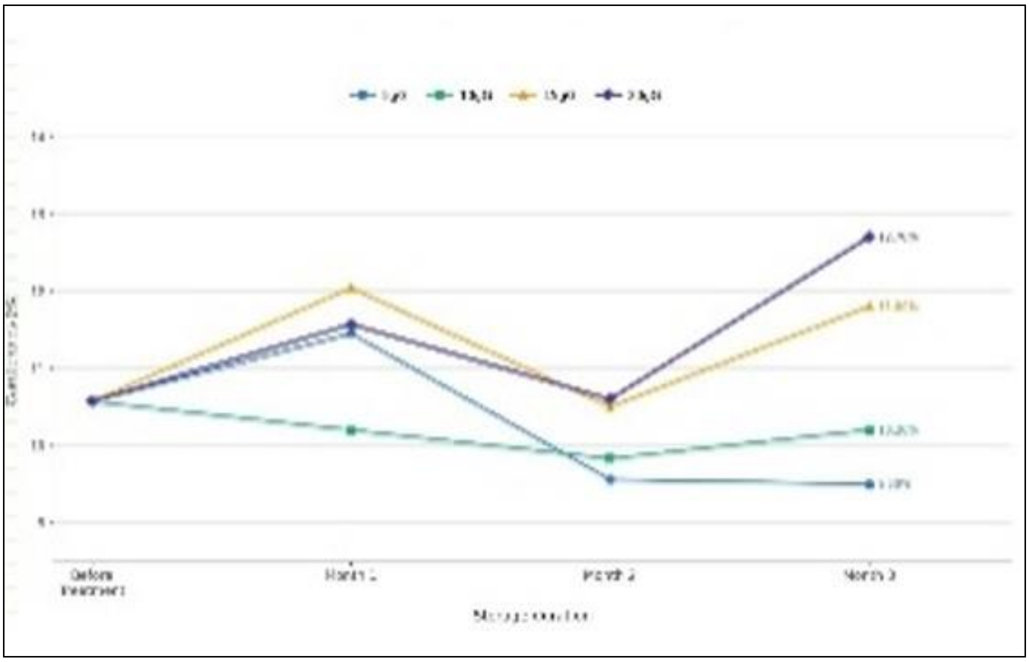

Fig 4: Effect of Ginger Powder Concentrations on Carotenoids Content of Stored Cowpea Over 3 Months

Discussion

The present study demonstrated that the application of ground ginger helped preserve the phytochemical quality of stored cowpea throughout the three-month storage period. The beneficial phytochemicals generally increased with increasing ginger concentration, whereas the untreated control showed lower retention, suggesting that ginger contributed to maintaining the bioactive compounds during storage.

The results for polyphenols showed that ginger-treated cowpea maintained higher polyphenol contents than the untreated samples throughout storage, particularly at the higher treatment levels. As shown in Figure 1, the 20g ginger treatment consistently recorded the highest polyphenol values, increasing from 9.54% before treatment to 12.90% after three months. Similarly, the 15g treatment showed a steady increase, while the 5g and 10g treatments produced moderate improvements. Polyphenols are recognised for their antioxidant activity and their ability to delay oxidative deterioration during food storage. The improved retention observed at higher ginger concentrations may be attributed to the antioxidant compounds naturally present in ginger, including gingerols, shogaols and phenolic constituents, which help reduce oxidative degradation (Semwal *et al*., 2015; Shahidi & Ambigaipalan, 2015) [9, 10].

The flavonoid content also improved throughout the storage period, with greater increases occurring as ginger concentration increased. Figure 2 shows that flavonoids increased progressively from 11.04% before treatment to 16.80% in cowpea treated with 20g of ginger after three months. The 15g treatment followed a similar pattern, whereas the 5g treatment recorded the least improvement. Flavonoids are important plant antioxidants that contribute to food quality and nutritional value by scavenging free radicals and protecting biological molecules from oxidative damage. The steady increase observed suggests that ginger powder effectively preserved these compounds during storage, thereby maintaining the nutritional quality of the stored cowpea (Ghasemzadeh and Ghasemzadeh, 2011; Mao *et al*., 2019) [5].

Lignan content followed a similar trend. As illustrated in Figure 3, the highest lignan values were obtained with the 20g ginger treatment, reaching 17.80% after three months, while lower concentrations showed smaller improvements. Although slight fluctuations were observed between the storage months, higher ginger concentrations consistently maintained greater lignan levels than lower concentrations. Lignans are naturally occurring phytochemicals with recognised antioxidant and health-promoting properties. Their better retention in ginger-treated samples further supports the preservative effect of ginger during storage by limiting phytochemical degradation.

Carotenoid retention varied slightly across the storage period but remained highest in samples treated with larger quantities of ginger. As presented in Figure 4, the 20g treatment recorded the highest carotenoid content (12.70%) after three months, followed by the 15g treatment (11.80%). In contrast, the 5g treatment showed a gradual decline over time. Carotenoids are particularly susceptible to oxidation during prolonged storage; therefore, the improved retention observed in the higher ginger treatments suggests that ginger reduced oxidative losses and helped preserve these important pigments (Mao *et al*., 2019) [5].

Overall, the results indicate a clear concentration-dependent effect of ginger powder on the preservation of beneficial phytochemicals in stored cowpea. Across all four phytochemical groups, higher concentrations of ginger, especially 15g and 20g, consistently maintained greater phytochemical levels throughout the storage period than lower concentrations. These findings agree with previous studies reporting that ginger contains natural antioxidant compounds capable of protecting food materials against oxidative deterioration during storage (Semwal *et al*., 2015; Mao *et al*., 2019) [5, 9]. The present findings therefore support the use of ground ginger as a safe and environmentally friendly natural preservative for improving the phytochemical stability and nutritional quality of stored cowpea.

Conclusion

Ground ginger effectively preserved the phytochemical quality of stored cowpea throughout the three-month storage period. Higher ginger concentrations, particularly 15g and 20g, maintained greater levels of beneficial phytochemicals, including polyphenols, flavonoids, lignans and carotenoids, than the untreated control. These findings indicate that ground ginger possesses good preservative properties that help protect the nutritional and functional quality of stored cowpea. Therefore, ground ginger can be recommended as a safe, natural and environmentally friendly alternative to synthetic storage chemicals for preserving the phytochemical quality of cowpea during storage.

References

1. AOAC International. Official methods of analysis of AOAC International. 18th ed. AOAC International, 2010. https://www.aoac.org
2. Boukar O, Belko N, Chamarthi S, Togola A, Batieno J, Owusu E, *et al*. Cowpea (*Vigna unguiculata*): Genetics, genomics and breeding. Plant Breeding,2019:138(4):415-424. https://doi.org/10.1111/pbr.12589
3. Food and Agriculture Organization of the United Nations. FAOSTAT statistical database. 2023. https://www.fao.org/faostat/
4. Ghasemzadeh A, Ghasemzadeh N. Flavonoids and phenolic acids: Role and biochemical activity in plants and human. Journal of Medicinal Plants Research,2011:5(31):6697-6703. https://doi.org/10.5897/JMPR11.1404
5. Mao QQ, Xu XY, Cao SY, Gan RY, Corke H, Beta T, *et al*. Bioactive compounds and bioactivities of ginger (*Zingiber officinale* Roscoe). Foods,2019:8(6):185. https://doi.org/10.3390/foods8060185
6. Nicolopoulou-Stamati P, Maipas S, Kotampasi C, Stamatis P, Hens L. Chemical pesticides and human health: The urgent need for a new concept in agriculture. Frontiers in Public Health,2016:4:48. https://doi.org/10.3389/fpubh.2016.00148
7. Onwuka GI. Food analysis and instrumentation: Theory and practice. Naphtali Prints, 2005.
8. Pitt JI, Hocking AD. Fungi and food spoilage. 4th ed. Springer, 2022. https://doi.org/10.1007/978-3-030-85677-9
9. Semwal RB, Semwal DK, Combrinck S, Viljoen AM. Gingerols and shogaols: Important nutraceutical principles from ginger. Phytochemistry,2015:117:554-568. https://doi.org/10.1016/j.phytochem.2015.07.012
10. Shahidi F, Ambigaipalan P. Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects—A review. Journal of Functional Foods,2015:18:820-897. https://doi.org/10.1016/j.jff.2015.06.018
11. Sharma A, Kumar V, Shahzad B, Tanveer M, Sidhu GPS, Handa N, *et al*. Worldwide pesticide usage and its impacts on ecosystem. SN Applied Sciences,2020:2: 1446. https://doi.org/10.1007/s42452-020-3127-0