Characterization of Legume-Derived Plant Milks: A Nutritional and Functional Analysis

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ABSTRACT

Background – Plant-based beverages have garnered significant attention due to their nutritional benefits and alignment with dietary preferences such as lactose intolerance, veganism, and sustainability.

Purpose – This study focuses on the development and characterization of plant-based milk formulations derived from a mixture of black bean with green bean, and black bean with red bean. The beans and resultant milk products were evaluated for their fatty acid profile, total phenolic content, and antioxidant activity.

Design/methodology/approach – All samples were extracted by dichloromethane-ethanol extraction. The crude extract will be further derivatization for fatty acid profile analysis. The spectrophotometry were used to analyze the total phenolic compound and antioxcidant activity of the the product.

Findings – Black beans demonstrated a high content of linolenic acid (41.74 ± 1.26%), surpassing green and red beans. Both plant-based milk formulations were rich in unsaturated fats, with monounsaturated fat ranging from 54.47% to 59.23% and polyunsaturated fat from 40.29% to 45.06%. The total phenolic content of black bean, red bean, and green bean were 2.38, 2.20, and 1.52 µg GAE/g DW, respectively. Antioxidant activity, assessed via % inhibition at 100 mg/ml, showed that black bean extracts exhibited the highest activity (75.05%), followed by red bean (64.1%) and green bean (64.5%). For the plant-based milk formulations, the antioxidant activity was 40.1% and 29.2% for black bean with red bean, and black bean with green bean, respectively.

Research limitations – The study focused on black bean, green bean, and red bean, which may not fully represent the diversity of legumes available globally.

Originality/value – The findings underscore the nutritional and functional potential of plant-based milk derived from legumes, particularly highlighting their unsaturated fat content and phenolic compound-mediated antioxidant activity. This study contributes to the growing field of sustainable, plant-based food innovations aimed at promoting health and addressing global dietary trends.

Keywords: *Plant-based milk*, *legume*, *total phenolic content*, *antioxidant activity*

INTRODUCTION

Plant-based beverages have garnered significant attention due to their nutritional benefits and alignment with dietary preferences such as lactose intolerance, veganism, and sustainability.

METHODS

Plant-based beverages

Research and Development

Microplate Spectrophotometer Multiskan™ GO (Thermo Scientific)

Gas Chromatography–FID (GC-2010, Shimazu)

RESULTS

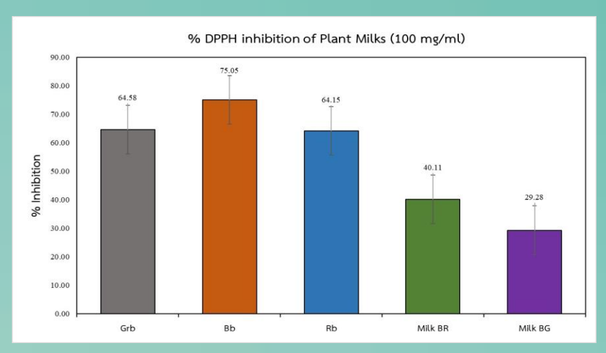

Figure 1. The % inhibition of plant milks.

Sample	TPC (ug GAE/g DW)
Green bean	1.52
Red bean	2.20
Black bean	2.38

Table 1. The total phenolic content of plant milks.

Fatty acid	Relative percentage composition of fatty acid (%)				
	Grb	Bb	Rb	Milk BR	Milk BG
Myristoleic (C14:1)	0.38±0.16	0.24±0.13	0.26±0.14	0.18±0.06	0.24±0.14
Palmitic (C16:0)	0.16±0.09	0.07±0.03	0.13±0.06	0.02±0.01	0.16±0.16
Palmitoic (C16:1)	25.57±0.81	31.42±0.60	28.24±1.62	26.62±1.25	27.73±0.26
Margaric (C17:0)	0.24±0.13	0.14±0.12	0.33±0.03	0.24±0.16	0.10±0.05
Stearic (C18:0)	0.16±0.07	0.13±0.14	0.15±0.11	0.13±0.13	0.09±0.03
Oleic (C18:1)	5.21±0.28	7.79±0.49	4.33±0.24	4.23±0.37	6.34±0.21
Linoleic (C18:2)	14.06±0.57	4.05±0.19	15.83±0.28	14.88±0.60	8.72±0.25
α-Linolenic (C18:3n6)	0.18±0.12	0.13±0.11	0.06±0.03	0.04±0.01	0.09±0.05
Linolenic (C18:3n3)	25.54±0.72	41.74±1.26	19.62±1.01	23.56±0.98	34.77±0.23
Arachidic (C20:0)	0.10±0.06	0.18±0.17	0.06±0.06	0.08±0.02	0.10±0.05
Gondoic (C20:1n9)	25.32±0.42	11.46±0.58	28.40±0.94	26.93±1.29	18.75±0.26
Eicosadienoic (C20:2)	0.08±0.03	0.07±0.05	0.06±0.02	0.14±0.12	0.15±0.13
Eicosatrienoic (C20:3n6)	0.15±0.05	0.12±0.05	0.05±0.02	0.08±0.04	0.09±0.05
Arachidonic (C20:4n6)	0.27±0.26	0.05±0.01	0.07±0.09	0.09±0.05	0.05±0.01
Erucic (C22:1)	1.21±0.21	1.42±0.34	1.05±0.02	1.13±0.11	1.37±0.08
Nervonic (C24:1)	0.14±0.21	0.14±0.10	0.05±0.05	0.14±0.10	0.04±0.02
Docosahexaenoic (C22:6)	1.25±0.17	0.89±0.31	1.33±0.25	1.50±0.09	1.17±0.13
Polyunsaturated (PUFA)	**41.51±0.57**	**47.04±1.10**	**37.02±1.03**	**40.29±0.55**	**45.06±0.12**
Munounsaturated (MUFA)	**57.83±0.80**	**52.47±1.25**	**62.32±1.16**	**59.23±0.36**	**54.47±0.18**
Saturated (SFA)	**0.66±0.23**	**0.52±0.24**	**0.67±0.12**	**0.47±0.26**	**0.46±0.23**

Table 2. The fatty acid composition of plant milks.

CONCLUSION

This study highlights the significant nutritional and functional properties of plant-based milk formulations derived from black bean and combinations with red bean and green bean. Black beans exhibited the highest linolenic acid content and antioxidant activity, contributing to the superior profile of the resulting formulations. Both plant-based milk formulations demonstrated high levels of unsaturated fatty acids, particularly monounsaturated and polyunsaturated fats, which are beneficial for cardiovascular health. The elevated phenolic content and antioxidant activity further underscore the potential health benefits of these legume-based products. These findings support the development of sustainable, nutrient-rich, plant-based milk alternatives that align with current dietary trends and preferences. Future research exploring a broader range of legumes and processing methods can further enhance the versatility and appeal of plant-based milk products.

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