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COMPARATIVE BACTERIOLOGICAL QUALITY ASSESSMENT OF SACHET AND CANNED BOURNVITA SOLD IN BAUCHI, NIGERIA

Hauwa Tahir[1]; Bashir Ismail Olawale[2]
[1]Department of Science Laboratory Technology, Abubakar Tatari Ali Polytechnic Bauchi
[2]Department of Microbiology, University of Abuja, Nigeria
Corresponding email: microbashes@gmail.com; Phone number

Abstract
Bournvita is a widely consumed cocoa-based malt beverage in Nigeria and serves as a fortified nutritional supplement for children and adults. Despite its classification as a low-moisture product, microbial contamination may occur during processing, packaging, storage, or post-opening handling. This study evaluated and compared the bacteriological quality of sachet and canned Bournvita of varying manufacturing ages obtained from Bauchi Central Market, Nigeria. Standard microbiological procedures including serial dilution, spread plate enumeration, Gram staining, and biochemical characterization were employed. Bacterial isolates identified included *Escherichia coli*, *Staphylococcus aureus*, *Streptococcus* spp., *Salmonella* spp., and *Klebsiella* spp. Results demonstrated a progressive increase in bacterial load with increasing manufacturing age, with canned samples generally exhibiting higher microbial counts than sachet samples. The detection of potential pathogens raises significant food safety concerns. These findings highlight the importance of packaging integrity, storage duration, and post-opening handling in determining the microbiological quality of cocoa-based beverages.

Keywords: Bournvita, microbial contamination, cocoa beverage, bacterial load, packaging, food safety, Nigeria

1. Introduction

Cocoa-based beverages represent a major category of fortified dietary supplements consumed globally. In Nigeria, Bournvita remains one of the most recognized and widely consumed melted chocolate drinks. The product is manufactured by Cadbury, a subsidiary of Mondelez International, and is marketed in several countries across Africa, Europe, and Asia. Bournvita is composed primarily of cocoa solids, sugar, glucose syrup, malt extract, milk solids, vitamins, and essential minerals (Jimmy *et al*., 2018). Its nutritional fortification, particularly with B-complex vitamins and vitamin D, contributes to its reputation as a health-enhancing beverage, especially among children and adolescents. Despite being categorized as a low water activity food product, powdered cocoa beverages are not entirely free from microbial risk. Low water activity inhibits microbial proliferation but does not eliminate microbial survival. Certain microorganisms, particularly spore-forming bacteria such as *Bacillus* and *Clostridium* species, possess the ability to withstand desiccation and thermal stress (Frazier & Westhoff, 1978). Furthermore, enteric pathogens such as *Salmonella* have been implicated in outbreaks associated with low-moisture foods, including chocolate and powdered milk products.

The production of cocoa-based beverages involves multiple stages that present opportunities for contamination. Cocoa fermentation is a microbiologically dynamic process involving yeasts, lactic acid

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bacteria, and acetic acid bacteria. While these microorganisms contribute to flavor development, inadequate hygiene during pod breaking, fermentation, drying, or storage may introduce pathogenic contaminants (Carr *et al*., 2009). Additionally, environmental exposure during grinding, blending, packaging, transportation, and retail handling further increases contamination risk. Packaging type is an important determinant of microbial stability. Sachet packaging is generally designed for single use, minimizing prolonged exposure after opening. In contrast, canned packaging is frequently opened multiple times before complete consumption. Each opening potentially introduces environmental microorganisms, moisture, and handling contaminants. The hygroscopic nature of powdered beverages further compounds this risk, as moisture absorption may facilitate microbial survival and, in some cases, limited growth. Given the widespread consumption of Bournvita in Nigeria, particularly among children who are more susceptible to gastrointestinal infections, it is imperative to evaluate its microbiological quality under real market conditions. This study therefore aimed to assess and compare the bacteriological quality of sachet and canned Bournvita of varying manufacturing ages sold in Bauchi, Nigeria.

2. Materials and Methods

2.1 Study Area

This study was conducted at Bauchi Central Market in Bauchi State, Nigeria, between July and October 2021. Bauchi is located in North-Eastern Nigeria and experiences a tropical climate characterized by distinct rainy and dry seasons.

2.2 Sample Collection

Three sets of sachets and canned Bournvita were purchased based on manufacturing age (one month, six months, and twelve months). Samples were transported aseptically to the Microbiology Laboratory of Abubakar Tafawa Balewa University, Bauchi.

2.3 Sample Processing and Microbiological Analysis

Serial dilution was performed up to 10^{-8} using sterile physiological saline (Cullen & Machin, 2016). Spread plate technique was employed for enumeration.

- Nutrient agar was used for total bacterial count.
- MacConkey agar was used for coliform count.

Plates were incubated at 37°C for 36–48 hours. Colony counts were expressed as colony-forming units per milliliter (CFU/ml).

2.4 Identification of Isolates

Isolates were identified based on colony morphology, Gram staining, and biochemical tests including catalase, coagulase, indole, and citrate utilization tests (Cheesbrough, 2006; Cowan & Steel, 1974).

2.5 Statistical Analysis

Data were analyzed using Analysis of Variance (ANOVA) to determine mean differences in bacterial counts among packaging types and manufacturing dates.

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3.0 Results and Discussion

The findings of this study demonstrate that both sachet and canned Bournvita samples harbored bacterial contaminants, with significant variations observed based on packaging type and manufacturing age.

Table 1: Cultural characteristic and microscopic on Nutrient Agar

Macroscopic characteristics	Microscopic characteristics	Suspected organisms
Greyish-white large spherical, colony,non-mucoid measured *4mm*	gram -ve, rod shape	*Escherichia coli*
Golden yellow spherical convex, opaque mucoid colony, measuring 3-4mm In diameter	gram +ve, cocci in cluster	*Staphylococcus spp*
Circular raised,mucoid, convex colony measuring 0.5mm in diameter	gram +ve cocci in chain	*Streptococcus spp*
Smooth colourless, spherical and convex colony, 4mm In diameter	gram -ve rod shape	*Salmonella spp*
Circular mucoid translucent greyish colony, 3mm in diameter	gram -ve rod shape	*Klebsiella spp*

Table 2: Bacterial count on both sachet and canned bournvita on nutrient agar

Bournvita	Manufacturing date	Average no of coliforms(cfu/ml)
Sachet	One month	2.6
Sachet	Six months	3.6
Sachet	Twelve months	5.3
Canned	One month	3.0
Canned	Six months	5.6
Canned	Twelve months	5.6

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Table 3: Gram reaction and biochemical characteristics of the isolates

Isolates codes	GR	CT	GT	ID	CUT	Suspected organism
RA	- ve rod	- ve	- ve	+ ve	- ve	*Escherichia coli*
RB	+ ve Cocci in cluster	+ ve	+ ve	- ve	-ve	*Staphylococcus aureus*
RC	+ ve Cocci chain	- ve	- ve	- ve	- ve	*Streptococcus spp.*
RD	- ve Rod	- ve	- ve	- ve	- ve	*Salmonella spp.*
RE	- ve	- ve	- ve	- ve	- ve	*Klebsiella spp.*

Keys: GR = Gram stain reaction; CT = Catalase test; GT = Coagulase test; CUT = Citrate utilization test ; ID = Indole Test

Table 4: Occurrence of Isolates in both sachet and Canned Bournvita.

Bournvita Samples						
	Sachets			Canned		
Isolates	One Month	Six Months	Twelve Months	One Month	Six Months	Twelve Months
Escherichia coli	_	+	+	+	+	+
Staphylococcus aureus	_	+	+	+	+	+
Streptococcus spp	_	_	+	-	+	+
Salmonella spp	_	_	_	_	_	+
Klebsiellaspp	_	_	_	_	_	+

Key: + = Present; - = Absent

The progressive increase in bacterial counts with increasing manufacturing age suggests that prolonged storage contributes to microbial persistence. This observation aligns with the findings of Jimmy *et al*. (2018), who reported increased bacterial load in cocoa-based beverages over time after opening. Although powdered beverages possess low water activity, they are hygroscopic and capable of absorbing atmospheric moisture, which may enhance microbial survival. Frazier and Westhoff (1978) emphasized that low moisture does not eliminate spore-forming bacteria, which can survive under dry conditions for extended periods.

The study observed that canned samples generally exhibited higher bacterial counts compared to sachet samples. This finding supports the hypothesis that repeated opening of canned products increases exposure to environmental contaminants. Similar observations were reported by Lehrians and Patterson (1988), who

documented progressive microbial increase in cocoa beverages after initial opening. The design of sachet packaging, often intended for single-use, reduces repeated exposure and may therefore contribute to lower contamination levels.

The isolation of *Escherichia coli* in both packaging types is particularly significant, as it indicates possible fecal contamination or inadequate hygiene during processing or handling. According to Cheesbrough (2006), *E. coli* serves as an indicator organism for sanitary quality. Its detection in a ready-to-consume powdered beverage suggests lapses in hygienic control either at the manufacturing or retail level.

The presence of coagulase-positive *Staphylococcus aureus* further supports the likelihood of handling contamination. This organism is commonly found on human skin and in nasal passages and is frequently associated with food handlers. Importantly, *S. aureus* produces heat-stable enterotoxins that may not be destroyed by moderate heating during beverage preparation. Pelczar *et al.* (1993) noted that staphylococcal food poisoning is one of the most common forms of foodborne illness worldwide. The detection of *Salmonella* spp. in older samples raises substantial public health concerns. Although the bacterial counts recorded were relatively low, *Salmonella* is known to survive in low-moisture foods and has been implicated in chocolate-related outbreaks globally. Carr *et al.* (2009) highlighted those cocoa products, despite low water activity, may harbor *Salmonella* if contamination occurs post-roasting. The occurrence of *Klebsiella* spp. and *Streptococcus* spp. further indicates environmental or handling contamination. While these organisms are often opportunistic pathogens, their presence in food products reflects compromised hygienic conditions. When comparing the present findings with previous studies, the trend of increased contamination with storage duration is consistent. Jimmy *et al.* (2018) reported a similar pattern of rising bacterial counts in cocoa-based beverages over time. However, the slightly higher counts observed in canned samples in this study suggest that packaging design plays a significant role in contamination dynamics.

From a public health perspective, the presence of enteric pathogens in a widely consumed children's beverage is concerning. Although many consumers prepare Bournvita using hot water or milk, improper preparation with lukewarm liquids may not eliminate bacterial toxins. Furthermore, cross-contamination during preparation may exacerbate risks.

Overall, the results indicate that packaging type, manufacturing age, and storage practices significantly influence the microbiological quality of Bournvita. These findings underscore the importance of strict hygienic controls throughout the production chain and enhanced consumer awareness regarding proper storage after opening.

3. Conclusion

The bacteriological quality of Bournvita sold in Bauchi varies according to packaging type and manufacturing age. Canned samples demonstrated relatively higher microbial loads compared to sachet samples. Bacterial contamination increased with storage duration. The isolation of potential pathogens such as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella* spp. indicates possible food safety risks. Although contamination levels were relatively low, their presence underscores the need for continuous quality monitoring and improved post-opening handling practices.

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