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Industrial Development and Valorization of Functional Cocktails from Local Fruits: Case of "*Alicament du Faso*" (ALIFA)

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Abstract

Introduction: In response to ongoing food insecurity in Burkina Faso, the transformation of local fruits into functional beverages emerges as an innovative nutritional strategy. **ALIFA** (*Alicaments du Faso*) contributes to this vision by valorizing indigenous plant resources. **Material:** Five functional fruit cocktails, based on roselle, locally known as bissap (*Hibiscus sabdariffa*), mango (*Mangifera indica*), banana (*Musa acuminata*), baobab (*Adansonia digitata*), orange (Citrus × sinensis), tangelo (*Citrus* × *tangelo*), and strawberry (*Fragaria* × *ananassa*), were selected. These formulations aim to combat nutritional deficiencies by providing essential fiber, minerals, and vitamins. **Method:** A descriptive quantitative study was conducted using the FAO/INFOODS Food Composition Database (2019). Nutritional values (energy, macronutrients, minerals, and vitamins) were calculated per 250 mL serving. Sensory acceptability was assessed using structured consumer testing, during which participants evaluated key attributes such as appearance, aroma, taste, texture, and

overall liking using standardized hedonic scales. **Results:** The mango-banana cocktail had the highest caloric value (181.15 kcal), while baobab-based cocktails were richest in fiber (up to 6.44 g). Baobab-strawberry displayed the highest vitamin C content (45.24 mg). Notable levels of potassium, calcium, and magnesium varied by formulation. Consumer testing showed high sensory acceptability, with favorable ratings for appearance, aroma, taste, texture, and overall liking, reflecting positive consumer perception. **Discussion:** The cocktails show strong nutritional and functional potential. However, limitations include high natural sugar content, insufficient levels of key micronutrients such as iron or calcium, and losses of sensitive vitamins during processing. **Conclusion: ALIFA**'s fruit-based cocktails offer a promising avenue for improving the nutritional status of populations. Technological enhancements, such as fortification and non-thermal preservation, are needed to maximize their public health impact and support sustainable, local food systems.

Keywords

Functional Beverages, Valorization of Local Fruits, Nutritional Composition, Agri-Food Industrial Development

1. Introduction

Burkina Faso, a Sahelian country, is among the most severely affected by food and nutritional insecurity in West Africa [1]. Between June and August 2022, several provinces, including Yagha, Soum, Séno, and Oudalan in the Sahel region, and Loroum in the North, faced acute food insecurity, with an alarming risk of famine [1]. Based on the results of the harmonized framework, twelve provinces were classified as phase 1 ("minimal"), seventeen as phase 2 ("under pressure"), and eleven provinces, including Bam, Sanmatenga, and Namentenga, as phase 3 (in crisis) [1].

In response to these persistent challenges, the transformation of local agricultural products has emerged as a potentially effective strategy to enhance food and nutritional security. However, numerous innovations in food processing have failed due to a lack of market insight and poor adaptation to consumer needs [2]. The emergence of health-oriented consumption trends over the last decade has brought the concept of health promotion to the forefront of healthcare and nutrition policies [3]. In particular, antioxidant-rich diets sourced from local ingredients are increasingly valued for their role in mitigating oxidative stress and preventing chronic illnesses [3].

The relationship between food and health is deeply rooted in traditional medical systems. Both Chinese and Indian medicines advocate dietary regimens that restore physiological balance, a principle echoed by the Pythagorean tradition, which linked nutrition to spiritual and physical harmony [4]. In addition, Hippocrates proclaimed: 'Let food be thy medicine and medicine be thy food.' In other words, Hippocrates, the Father of Western Medicine, emphasized the founda-

tional importance of nutrition in promoting and maintaining population health [5]-[11]. The close relationship between diet and human health, supported by robust scientific evidence [7] [9] [12]-[16], supports the recognition of a balanced diet as a fundamental pillar of public health [17].

Industrialized nations have increasingly endorsed the therapeutic potential of food, promoting diets tailored to address lifestyle diseases such as diabetes, hypercholesterolemia, and obesity. These developments have led to the emergence of "functional foods" or "nutraceuticals", products that go beyond basic nutrition by offering therapeutic or preventive health benefits [4].

In West Africa, local food consumption is now associated with multifaceted benefits, including economic empowerment, *e.g.*, increased income for farmers, job creation, and the development of agri-food small and medium enterprises (SMEs), reduced food dependency, enhanced school enrollment, improved healthcare access, and environmental sustainability. Notably, the promotion of local food systems also supports women's empowerment and contributes to reducing social inequalities [18]. The evolving expectations of consumers, especially those prioritizing health, have stimulated the demand for food products that provide both nutritional value and functional benefits. Functional foods, therefore, represent a significant opportunity for innovation within the food industry, meeting nutritional needs while promoting health and well-being [19].

In this context, "*Alicaments du Faso*" (ALIFA), a local agri-food enterprise established in 2024, seeks to transform indigenous plant-based resources into value-added food products that contribute to good nutritional status and disease prevention. The company's focus on functional beverages aligns with the urgent need to diversify and enrich the diets of vulnerable populations. For example, in Burkina Faso, among children aged 6 to 23 months, eight out of ten fail to meet the minimum dietary diversity required for healthy growth and development [20]. These statistics underscore the necessity of locally adapted innovations that integrate nutrition, health, and food sovereignty.

The present study evaluates the development and nutritional composition of **ALIFA's** functional fruit cocktails. Specifically, it investigates how these products, formulated from locally sourced ingredients, can provide sustainable responses to nutritional deficiencies, reinforce local food systems, and promote health among various demographic groups.

2. Material and Method

2.1. Study Context and Product Selection

The research was conducted at Aliments du Faso (**ALIFA**), an agri-food enterprise based in Ouagadougou, Burkina Faso, dedicated to the development of affordable, safe, and nutritionally valuable products from locally sourced plant resources through the integration of traditional food practices and modern processing technologies, with a focus on nutritional improvement, food security, and the valorization of indigenous fruits with functional and bioactive potential.

Within this framework, five functional beverages—Bissap-orange, Bissap-tangelo, Mango-banana, Baobab-banana, and Baobab-strawberry were selected from **ALIFA**'s pilot production line and formulated according to standardized recipes designed to address common micronutrient deficiencies by combining complementary fruits rich in vitamins, minerals, polyphenols, and organic acids.

Specifically, the hibiscus-based cocktails were prepared from aqueous infusions of *Hibiscus sabdariffa* calyces blended with orange or tangelo juice, grenadine, mint, clove, and water; the mango-banana beverage from blended *Mangifera indica* and *Musa acuminata* pulps with added sucrose, mint, and water; and the baobab-based formulations from reconstituted *Adansonia digitata* pulp combined with strawberry or banana, sucrose, mint, and water.

The selection of ingredients and their relative proportions was defined a priori to optimize nutritional complementarity (notably vitamin C, dietary fiber, potassium, and polyphenols), sensory balance, and scalability for community-level production, and thus constitutes an integral part of the formulation methodology rather than study outcomes.

2.2. Description of the ALIFA Beverage Production Process

The production of ALIFA beverages follows a controlled agro-food processing chain designed to preserve nutritional quality, ensure microbiological safety, and guarantee consumer acceptability.

Fresh local fruits and plant materials, such as hibiscus calyces, citrus fruits, and ginger, are first selected at reception based on maturity, integrity, and compliance with predefined quality criteria to ensure a high-quality raw matrix. The selected materials are then manually sorted, thoroughly washed with potable water, and subjected to a food-grade sanitization step to reduce surface microbial contamination and remove adhering soil and impurities. Depending on the nature of the raw material, preparation operations, including peeling, deseeding, slicing, or crushing, are performed. These size-reduction steps increase the contact surface, thereby facilitating the efficient extraction of bioactive compounds.

Extraction of functional components is subsequently carried out either by aqueous infusion or by mechanical pressing, with strict control of time and temperature to preserve polyphenols, vitamins, and aroma compounds while minimizing degradation. The resulting extract is filtered to eliminate insoluble residues and fibers, producing a clarified and homogeneous beverage base. Formulation and standardization follow, with the controlled addition of sweeteners, spices, or functional ingredients and adjustment of pH and °Brix to ensure stability and sensory consistency. A mild pasteurization treatment is then applied to guarantee microbiological safety without compromising nutritional or organoleptic quality. Finally, the beverage is filled into clean containers under hygienic conditions, sealed, labeled, and stored appropriately to maintain product quality and shelf life.

2.3. Study Design and Data Collection Approach

A quantitative descriptive study design was employed to evaluate the theoretical

nutritional composition and functional potential of the selected beverages. This approach aimed to estimate macro- and micronutrient contents, as well as key bioactive components, based on the known composition of the raw ingredients used in each formulation. Nutritional data were sourced from the FAO/INFOODS Food Composition Database for Western Africa (2019), which provides standardized and region--specific reference values for local food materials.

Ingredient-level compositional data were extracted and adjusted according to formulation ratios and processing yields. Calculations were performed using Microsoft Excel, allowing systematic aggregation, normalization per serving size, and comparison across beverage formulations. This method enabled a structured assessment of expected nutritional value and functional attributes, while acknowledging that the results represent theoretical estimates rather than experimentally measured values.

The sensory analysis was conducted using a consumer acceptability test, corresponding to an affective sensory analysis rather than an analytical or descriptive one. This approach was chosen to obtain preliminary information on consumer perception and overall liking, using a targeted non-professional panel representative of potential consumers.

The evaluation focused on key sensory descriptors, specifically taste and texture, which are critical attributes for beverage acceptance. Panelists assessed these attributes using a standardized hedonic rating scale, allowing them to express their degree of liking. The scores were subsequently compiled and analyzed to provide an overall indication of sensory acceptability, complementing the theoretical nutritional assessment standardized per 250 mL serving.

2.4. Limitations and Operational Constraints

While the study offers a relevant theoretical characterization of the product composition, it is constrained by the absence of direct laboratory analyses, such as physicochemical, microbiological, and nutritional testing, which would be necessary to experimentally validate the proposed formulations. The work relies primarily on secondary data from the literature and existing databases, which, although scientifically credible, may not fully capture variability related to raw materials, processing conditions, or formulation-specific interactions. Furthermore, the products evaluated remain at a non-commercial, pilot-stage level, limiting the extrapolation of results to industrial-scale production and market conditions.

In addition, constraints related to time, infrastructure, and financial resources restricted the scope of experimental validation. These limitations prevented the implementation of long-term stability studies, shelf-life assessment, and repeated batch-to-batch evaluations. Sensory analysis was also limited in scale, both in terms of the number of participants and the diversity of consumer profiles, thereby reducing the statistical robustness and generalizability of consumer acceptance data. Collectively, these factors highlight the need for future studies incorporating comprehensive laboratory analyses, extended storage trials, and large-scale sen-

sory panels to support product standardization and commercial development.

3. Results

3.1. Nutritional Composition Analysis

The cocktails were assessed for their energy content, macronutrients, mineral profile, and vitamin composition using standard reference values from the FAO/INFOODS Food Composition Database for Western Africa (2019) [21].

3.1.1. Energy Value and Macronutrient Content

Energy value and macronutrient content (carbohydrates, proteins, lipids, and dietary fibers) were calculated for each cocktail based on a 250 mL serving. The results are summarized in Table 1.

In order to distinguish the contribution of intrinsic fruit sugars from that of added sucrose to the total carbohydrate content reported in Table 1, the quantity of added sugar was standardized during formulation. For the mango-banana, baobab-banana, and baobab-strawberry cocktails, refined sucrose was incorporated at a level of 6% (w/v), corresponding to 15 g of added sugar per 250 mL serving. In the bissap-orange and bissap-tangelo formulations, sweetness adjustment was achieved using 4% (w/v) sucrose, equivalent to 10 g per 250 mL, due to the naturally higher acidity of *Hibiscus sabdariffa* extracts. Consequently, the remaining fraction of total carbohydrates presented in Table 1 originates from the natural sugars of the fruits (glucose, fructose, and sucrose) as calculated from the FAO/INFOODS database. This specification allows a clear differentiation between carbohydrates derived from the fruit matrix and those supplied by technological addition of sucrose, and supports a more accurate nutritional interpretation of the formulations.

Table 1. Energy value and macronutrient composition (250 mL) [21].

Cocktails	Carbohydrates [g]	Fiber [g]	Proteins [g]	Lipids [g]	Energy [kcal]
Bissap-orange	32.09	2.12	1.13	0.34	135.99
Bissap-tangelo	33.94	2.16	1.17	0.31	139.59
Mango-banana	43.24	2.11	1.27	0.24	181.15
Baobab-strawberry	26.61	6.10	0.66	0.14	109.40
Baobab-banana	30.98	6.44	0.77	0.11	128.76

Among the five formulations, Mango-banana provided the highest caloric value (181.15 kcal/250 mL), followed by "*Bissap-tangelo*" (139.59 kcal/250 mL), while "*Baobab-strawberry*" offered the lowest (109.40 kcal/250 mL). In terms of fiber content, baobab-based cocktails were notably superior, with "*Baobab-banana*" (6.44 g/250 mL) showing the highest fiber concentration. Overall, all formulations presented relatively high carbohydrate contents compared with typical fruit juice

carbohydrate levels, making them potential sources of rapid energy.

3.1.2. Mineral Composition

Minerals such as calcium, magnesium, potassium, and iron are critical for maintaining electrolyte balance, bone metabolism, oxygen transport, and enzymatic functions. Table 2 presents the mineral composition per 250 mL serving.

Table 2. Mineral Composition (mg/250 mL) [21].

Cocktails	Calcium [mg]	Copper [mg]	Iron [mg]	Magnesium [mg]	Phosphorus [mg]	Potassium [mg]	Sodium [mg]	Zinc [mg]
Bissap-orange	69.64	0.21	1.77	27.13	21.70	201.75	16.72	0.12
Bissap-tangelo	72.84	0.21	1.75	27.53	22.10	203.35	16.72	0.12
Mango-banana	56.24	0.21	1.75	30.89	24.28	297.43	14.59	0.12
Baobab-strawberry	59.85	0.25	1.28	28.71	18.39	313.09	12.78	0.12
Baobab-banana	61.39	0.27	1.55	33.21	17.60	357.24	14.01	0.13

The *Baobab-banana* cocktail displayed the highest magnesium (33.21 mg) and potassium (357.24 mg) contents, while *Bissap-tangelo* presented the highest calcium concentration (72.84 mg). All formulations provided moderate iron levels, with *Bissap-orange* being slightly higher than the rest.

3.1.3. Vitamin Composition

Vitamin content analysis focused on essential micronutrients, including vitamin C, B-complex vitamins (B2, B3, B6), vitamin A, and vitamin E. The results are detailed in Table 3.

Table 3. Vitamin composition (mg/250 mL) [21].

Cocktails	Vitamin A [mg]	Vitamin B2 [mg]	Vitamin B3 [mg]	Vitamin B6 [mg]	Vitamin C [mg]	Vitamin E [mg]
Bissap-orange	0.07	0.02	0.46	0.09	24.31	0.24
Bissap-tangelo	0.08	0.02	0.49	0.10	16.59	0.11
Mango-banana	0.13	0.01	0.76	0.22	21.02	0.59
Baobab-strawberry	0.02	0.02	0.49	0.03	45.24	0.02
Baobab-banana	0.02	0.03	0.59	0.08	34.97	0.07

Baobab-strawberry had the highest vitamin C content (45.24 mg), followed by *Baobab-banana* (34.97 mg), confirming the high antioxidant potential of *Adansonia digitata*-based formulations. *Mango-banana* was richest in niacin (0.76 mg), vitamin B6 (0.22 mg), vitamin A (0.13 mg), and vitamin E (0.59 mg), reflecting the nutrient density of tropical fruits like mango and banana.

These findings underscore the nutritional diversity of **ALIFA's** formulations and

highlight the potential of local fruit-based beverages as functional food supplements tailored to address specific dietary insufficiencies in the Burkinabè population.

3.2. Quantitative Sensory Acceptability

Consumer acceptability testing, performed using a structured hedonic scale as described in the Methods section, revealed high overall liking for all five ALIFA formulations. Mean hedonic scores (± SD) for appearance, aroma, taste, texture, and overall acceptance were consistently above the neutral midpoint of the scale, indicating good to very good consumer appreciation. Among the formulations, the mango-banana cocktail showed the highest overall liking, driven primarily by significantly higher scores for sweetness-acidity balance and mouthfeel, whereas the baobab-based beverages (baobab-banana and baobab-strawberry) were particularly appreciated for their texture and refreshing character. Hibiscus-based drinks (bissap-orange and bissap-tangelo) obtained high scores for color intensity and aroma, reflecting the strong visual and aromatic appeal of anthocyanin-rich calyces and citrus notes.

The numerical sensory data are summarized in Table 4. All formulations obtained mean hedonic scores above 7 for overall liking, indicating good to very good consumer acceptability. The mango-banana cocktail exhibited the highest overall score (8.3 ± 0.7), followed by the baobab-strawberry (7.9 ± 0.8) and baobab-banana (7.8 ± 0.9) beverages, mainly due to their favorable texture and sweetness balance. Hibiscus-based cocktails showed particularly high scores for appearance and aroma, reflecting the strong visual and aromatic impact of anthocyanins and citrus volatiles. These quantitative results confirm that all ALIFA formulations are sensorially acceptable, with significant inter-product differences in specific attributes.

Table 4. Hedonic scores for sensory attributes of ALIFA functional cocktails.

Formulation	Appearance	Aroma	Taste	Texture	Overall Liking
Bissap-orange	7.2 ± 1.1	7.4 ± 1.0	7.0 ± 1.2	6.9 ± 1.1	7.1 ± 1.0
Bissap-tangelo	7.3 ± 1.0	7.5 ± 0.9	7.1 ± 1.1	7.0 ± 1.0	7.2 ± 0.9
Mango-banana	8.1 ± 0.8	8.0 ± 0.9	8.3 ± 0.7	8.2 ± 0.8	8.3 ± 0.7
Baobab-strawberry	7.6 ± 0.9	7.3 ± 1.0	7.8 ± 0.9	8.0 ± 0.8	7.9 ± 0.8
Baobab-banana	7.5 ± 0.9	7.2 ± 1.1	7.6 ± 1.0	8.1 ± 0.7	7.8 ± 0.9

Scores: mean ± SD and n = 45 panelists. Scores are expressed on a 9-point hedonic scale (1 = dislike extremely; 9 = like extremely).

4. Discussion

4.1. Nutritional Significance of ALIFA Cocktails

4.1.1. Energy Value and Macronutrient Composition

Among the cocktails analyzed, the *Mango-banana* formulation exhibited the highest energy value (181.15 kcal per 250 mL), a result attributable to the naturally

high caloric density of mango and banana. According to Djantou *et al.* [9], mango pulp offers 50 - 60 kcal per 100 g depending on variety, while banana averages 89 kcal per 100 [21]. This energy profile makes the cocktail particularly suitable for populations with elevated caloric demands, such as athletes, children undergoing growth spurts, and individuals recovering from malnutrition [22], given the importance of carbohydrate intake for glycogen repletion post-exercise [23] and the fact [24] that carbohydrate supplementation prolongs endurance and delays fatigue through stabilization of glycemia and glycogen oxidation.

In addition to energy, the Mango-banana cocktail displayed the highest protein content (1.27 g per 250 mL). Although the mango-banana cocktail exhibited the highest protein level among the formulations (1.27 g per 250 mL), this value should not be described as "high" in absolute nutritional terms, nor should it be presented as sufficient on its own to prevent or mitigate sarcopenia. In fact, when contextualized against standard dietary recommendations, adult protein needs are about 0.8 $g \cdot kg^{-1} \cdot day^{-1}$ and rise to 1.0 - 1.2 $g \cdot kg^{-1} \cdot day^{-1}$ in older adults, corresponding to roughly 48 - 84 g/day for a 60 - 70 kg person. A 250 mL serving providing 1.27 g of protein therefore supplies less than 3% of daily requirements and cannot be considered a significant protein source. It should be viewed as a minor complementary contribution within a diversified diet, rather than a protein-rich food or an effective stand-alone strategy for preventing sarcopenia.

Protein intake is critical for muscle maintenance, especially among elderly populations. While Health Canada recommends 0.8 g/kg/day [25], recent literature [26] supports higher intake (1.0 - 1.5 g/kg/day) for older adults.[27] As dietary intake often decreases with age [28], low-protein fruit beverages such as ALIFA's formulation may only contribute marginally to daily protein intake. The role of plant-derived proteins in complementing dietary protein diversity is increasingly emphasized in geriatric nutrition, especially in contexts where animal protein is less accessible.

Lipid content across all cocktails was low, which aligns with dietary recommendations for cardiovascular health. A fruit-rich, low-lipid diet reduces the risk of dyslipidemia and atherosclerosis [29]. Moreover, the absence of trans-fatty acids is noteworthy, as their inflammatory impact is well documented [30]. Lipid moderation is particularly important in populations at risk for metabolic syndrome, and the inclusion of such low-fat beverages in institutional nutrition programs may help reduce cardiovascular morbidity.

The baobab-based cocktails, *i.e.*, *Baobab-strawberry* and *Baobab-banana*, demonstrated high dietary fiber content (6.10 g and 6.44 g per 250 mL, respectively). Baobab pulp, containing up to 52% fiber [31], provides both soluble and insoluble fractions with functional roles in glycemic regulation, digestion, and lipid metabolism [32]. Strawberries, contributing pectin and phenolic compounds, further enhance these properties [33]. Given the Institute of Medicine's recommendation of 25 g/day fibers for women and 38 g/day for men [33], these beverages can contribute meaningfully to daily fiber intake.

Additionally, fiber is known to modulate gut microbiota, improve bowel regularity, and reduce the glycemic index of meals. The prebiotic effect of dietary fiber, especially when derived from diverse plant matrices, provides significant long-term benefits for digestive health and systemic inflammation.

4.1.2. Mineral Composition

The mineral profiles of the cocktails highlight their functional relevance. Potassium content was particularly elevated in the baobab-based variants (313.09 mg and 357.24 mg), consistent with baobab's known mineral richness [31]. This finding is important with respect to Weaver's findings [34] on the cardioprotective and antihypertensive effects of potassium. Furthermore, potassium contributes to acid-base balance, cellular hydration, and neuromuscular activity, making these beverages especially beneficial for individuals with high fluid and electrolyte turnover.

Calcium levels were higher in the hibiscus-based cocktails (69.64 - 72.84 mg/250 mL), which would thus be favorable for bone health [35], given that calcium intake significantly influences bone mass accrual and fracture risk. The role of sweat-related calcium loss, especially in physically active individuals, further highlights the importance of calcium-rich beverages [36].

Magnesium, notably high in the *Baobab-banana* cocktail (33.21 mg), contributes to enzymatic activity, mitochondrial stability, and neuromuscular transmission [37]. It also plays a role in regulating glucose metabolism, making it a relevant nutrient in diabetes prevention strategies.

Phosphorus content, while moderate (up to 24.28 mg in *Mango-banana*), is essential for ATP synthesis and bone integrity [38]. The phosphorus-to-calcium ratio is also balanced in these beverages, supporting synergistic absorption in bone tissue remodeling.

Sodium levels remained within moderate ranges (12.78 - 16.72 mg), contributing to hydration and electrolyte balance without exacerbating cardiovascular risk, as recommended by the WHO [39]. For individuals engaged in physical activity or experiencing heat exposure, such sodium concentrations may support optimal fluid retention and performance.

Trace elements, such as iron, zinc, and copper, though present in lower quantities, contribute to oxygen transport, immune regulation, and antioxidant defense [40] [41]. Their inclusion, even at modest levels, is especially important in addressing latent micronutrient deficiencies prevalent in rural and peri-urban populations of Sub-Saharan Africa. Data from Chile [42] confirm the nutritional relevance of such micronutrients even in low concentrations.

4.1.3. Vitamin Composition

Vitamin C was highest in the *Baobab-Strawberry* cocktail (45.24 mg/250 mL), confirming baobab's documented richness [3]. Its antioxidant potential is reinforced by synergistic interactions with polyphenols, as demonstrated in various studies [43]-[45]. Vitamin C also supports immune defense, iron absorption, and endothelial function, and plays a preventive role against respiratory infections and anemia.

The *Mango-Banana* cocktail offered significant vitamin C (21.02 mg), in addition to carotenoids and mangiferin [46] [47], with documented antioxidant and anti-inflammatory effects. These compounds act at the mitochondrial and cellular membrane levels to scavenge free radicals and reduce oxidative stress biomarkers. In other studies, it was shown that Hibiscus-based cocktails provided additional polyphenolic antioxidants and anthocyanins with antihypertensive and anti-cancer potential [48] [49]. The presence of these compounds is of particular interest in chronic disease prevention strategies.

B-complex vitamins are present only in low concentrations in the various cocktails under study. Yet their biochemical roles are essential [50] and thus even low concentrations might already have a positive impact. Vitamin B1 (thiamine) supports neuronal integrity, B2 (riboflavin) enables coenzyme activity, B3 (niacin) modulates metabolism, and B6 (pyridoxine) contributes to neurotransmitter synthesis. Their deficiency can compromise cognitive and muscular performance. Vitamin E (tocopherol and derivatives) provides lipid membrane protection [51], while vitamin A (retinol), though limited in content, is crucial for epithelial maintenance [52]. These liposoluble vitamins, even in low doses, contribute to the stability of cellular systems and should be preserved during formulation processes.

4.2. Functional and Health Benefits

To avoid any implication that the ALIFA cocktails themselves have clinically demonstrated therapeutic effects, this section clearly distinguishes between the documented bioactivities of the raw plant ingredients as reported in the scientific literature, and the theoretical functional potential of the formulated beverages, which remains to be confirmed by *in-vivo* and clinical studies. This approach is consistent with current regulatory and scientific standards for functional foods and nutraceuticals.

4.2.1. Established Bioactivity of the Raw Ingredients

Hibiscus sabdariffa calyces are widely reported to be rich in anthocyanins, organic acids, and polyphenols with antioxidant, antihypertensive, anti-inflammatory, and antimicrobial activities demonstrated in vitro, in animal models, and in some human studies [53]-[55].

Citrus fruits (orange and tangelo) provide vitamin C, flavanones (hesperidin, naringenin), and limonoids, which exhibit antioxidant and anti-inflammatory properties and are associated with cardiometabolic health in observational and intervention studies [56] [57].

Mangifera indica pulp contains carotenoids, vitamin C, and polyphenols such as mangiferin, which have shown antioxidant, anti-inflammatory, antidiabetic, and antiproliferative activities in cellular and animal models [58]-[62].

Musa spp. (banana) provides readily available carbohydrates, potassium, and resistant starch, with reported benefits for energy supply, gut health, and glycemic modulation [63].

Adansonia digitata (baobab) pulp is characterized by a high content of vitamin C, soluble and insoluble fibers, calcium, potassium, and polyphenols. Experimental studies attribute antioxidant, hepatoprotective, anti-inflammatory, and prebiotic effects to baobab [64]-[66].

Fragaria × *ananassa* (strawberry) is a recognized source of anthocyanins, ellagic acid, and vitamin C, with well-documented antioxidant and cardiometabolic protective properties [67].

Overall, these data indicate that the raw ingredients used in the ALIFA formulations possess bioactive compounds with demonstrated biological activities in experimental and, for some endpoints, clinical contexts. However, such evidence relates to extracts, isolated compounds, or specific consumption patterns, and not directly to the formulated cocktails.

4.2.2. Theoretical Functional Potential of the ALIFA Cocktails

The ALIFA beverages result from the combination of fruits known to be rich in vitamins, minerals, fibers, and polyphenolic compounds, processed through aqueous extraction, blending, and mild heat treatment. Based on their calculated nutritional composition (**Tables 1-3**) and the phytochemical profiles reported for the raw ingredients, these formulations may theoretically be regarded as nutritionally functional beverages. They are expected to provide antioxidant compounds, mainly vitamin C and diverse polyphenols, which are generally associated with the modulation of oxidative stress.

The baobab-based formulations, in particular, supply appreciable amounts of dietary fiber, which may support digestive physiology and contribute to glycaemic regulation. The presence of essential minerals such as potassium, magnesium, and calcium suggests a potential contribution to electrolyte balance, neuromuscular function, and cardiovascular homeostasis. In addition, the mango-banana cocktail, owing to its higher carbohydrate and energy content, may represent a convenient source of dietary energy for individuals with increased caloric requirements.

It must, however, be clearly stated that these functional attributes are inferred from theoretical nutritional calculations and from published data on the bioactivity of the raw plant materials, rather than from direct measurements of bioactive compound retention in the finished products. Furthermore, no in vivo, clinical, or intervention studies have yet been conducted to evaluate the physiological effects of the **ALIFA** cocktails as consumed.

Consequently, these beverages cannot be presented as having proven preventive or therapeutic effects against specific pathologies, such as cancer, hypertension, diabetes, or infectious diseases. Their positioning should therefore remain that of nutritionally enriched functional drinks that may contribute to general well-being when integrated into a balanced diet, in accordance with the conceptual and regulatory frameworks defined by FAO, WHO, and EFSA for functional foods.

4.2.3. Regulatory and Scientific Framework Supporting This Positioning

This cautious interpretation is consistent with international scientific and regula-

tory guidance on health claims for foods. The European Food Safety Authority emphasizes that claims associated with foods must be supported by rigorous evidence and must not imply disease prevention or treatment in the absence of clinical substantiation (EFSA NDA Panel, 2017).

Similarly, the World Health Organization, in its report on diet, nutrition, and the prevention of chronic diseases, recognizes the protective role of fruit- and vegetable-rich diets in population health while clearly distinguishing nutritional risk reduction from therapeutic intervention (WHO, 2003). European Regulation (EC) N˚ 1924/2006 further formalizes the distinction between nutritional or functional claims and medicinal claims, restricting the latter to products evaluated and authorized as drugs.

Finally, the FAO's conceptual framework on functional foods underlines that such products may support physiological functions and contribute to health maintenance, but should not be presented as treatments for disease without appropriate clinical evidence. These references provide a solid basis for framing the ALIFA cocktails as functional, nutrition-oriented beverages rather than as clinically validated therapeutic agents.

4.3. Study Limitations

Despite their natural composition and promising nutritional profile, **ALIFA's** fruit-based functional cocktails present several limitations that must be addressed to enhance their public health impact. First, their high natural sugar content, though derived from fruits and additionally increased by the addition of sugar, may contribute to metabolic risks such as diabetes and hypertension when consumed in excess, as highlighted by Malik *et al.* [68] and Wang *et al.* [69]; thus, reformulation strategies involving low-glycemic fruits, dilution, or fiber enrichment are recommended.

Second, although the cocktails are rich in vitamin C, they provide insufficient quantities of essential minerals such as iron and calcium to meet daily requirements, particularly for vulnerable groups like women and children, as noted by the FAO (2013) and the WHO (2004); targeted fortification or the inclusion of nutrient-dense components such as moringa or algae could improve their micronutrient profile [70].

Third, vitamin C and other thermolabile nutrients are highly sensitive to heat and oxidative degradation during pasteurization and storage, with studies by Lee & Kader [71] and De Ancos *et al.* [72] reporting significant losses under conventional processing conditions; to mitigate this, non-thermal technologies, the use of antioxidant stabilizers, and protective packaging should be explored. Thus, while these cocktails hold great potential as culturally appropriate and nutritionally beneficial functional beverages, optimizing their formulation, preservation, and nutritional density remains essential for maximizing their role in combating malnutrition and promoting food security in Burkina Faso.

5. Conclusions

At the conclusion of this study, it is important to underscore that the transformation of local products represents a key lever in addressing the nutritional and food challenges faced by many populations, particularly in Burkina Faso.

The various cocktails developed from locally available fruits such as hibiscus, baobab, banana, mango, orange, and strawberry stand out not only for their nutritional richness in calories, primary metabolites, minerals, and vitamins, but also for offering concrete responses to various nutritional problems. In addition to their nutritional role, these beverages meet a growing demand for healthy, safe, accessible, and locally adapted food products.

The **ALIFA** initiative to promote local products exemplifies innovation in local agro-food transformation. This approach not only improves the availability and diversity of food products but also contributes to combating nutritional deficiencies. Beyond the nutritional aspect, these products respond to increasing needs for food solutions that combine nutritional quality and food safety. By combining ingredients with antioxidant, vitamin, and mineral properties, **ALIFA** contributes to food diversification and health improvement by offering products that support general well-being and help prevent certain diseases.

This approach to local product transformation also enhances population resilience to food crises by stimulating the local agro-industrial sector. It presents a dual advantage: creating economic opportunities for farmers and producers, while also meeting the growing demand for safe and sustainable food solutions. By unlocking the potential of local products through innovative transformation, **ALIFA** actively contributes to the development of secure food solutions that support both food and nutritional security in the long term.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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