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Ensuring Food Safety as Basic Human Right: A Review on the Procedures and Approach

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Abstract

Billions of people in the world are at risk of unsafe food. Many millions become sick while hundreds of thousands die every year because they consume unsafe food. Therefore, safe food saves lives. Food safety encompasses the practical actions and scientific principles implemented to ensure that food items are safe for human consumption, devoid of contamination, and do not threaten public health. The present study reviews various procedure and approach in ensuring food safety. It was established that to ensure food safety, enterprises must actively engage in two levels of action: preventing both accidental and intentional food contamination. Also, the review highlights various approaches toward ensuring safety of food which focuses on preventing, eliminating, or minimising the presence of microbiological, chemical, and physical risks.

KEYWORDS: Food Safety, Food Poison, Public Health, Food Contamination

Introduction

The worldwide food business is increasingly interested in developing functional food (FF) items that might influence digestion and physiological reactions. This topic has been studied by researchers such as Donato-Capel et al. (2014) and Fu et al. (2022). Functional foods (FF) are dietary items that provide nutrients and energy and can positively influence specific bodily processes. They achieve this by increasing particular physiological responses and reducing the risk of disease (Donato-Capel et al., 2014). The global demand for gluten-free (GF) products, including bakery items, pastries, cakes, sweets, ice-creams, ready meals, dairy and dairy alternatives, meat and meat substitutes, sauces, seasonings, spreads, pasta, and rice, is steadily increasing (Monteiro et al., 2021). The prevalence of gluten intolerance, resulting in celiac disease and many health complications (Ren et al., 2020; Cappelli et al., 2020), has escalated on a global scale. As a result, there has been an increase in the demand for gluten-free products from both researchers and consumers (Ren et al., 2020; Cappelli et al., 2020).

The increasing popularity of the gluten-free diet has a distinct impact on consumers, food manufacturers, and health professionals. The food industry has been compelled by consumer expectations to consistently adapt and enhance the formulations and processing techniques employed in producing gluten-free products. Health professionals have shown interest in assessing the diet's nutritional sufficiency and efficacy in addressing gluten-related diseases and other conditions (El Khoury et al., 2018). Gluten-related disorders (GRD) encompass three main categories of gluten reactions: allergic (wheat allergy), autoimmune disorders (celiac disease (CD), dermatitis herpetiformis, gluten ataxia), and potentially immune-mediated disorder (gluten sensitivity) (Barak et al., 2014; Monteiro et al., 2021). Coeliac illness, wheat allergy, and non-celiac gluten sensitivity are conditions that can lead to significant health issues in individuals who consume even small quantities of gluten (Culetu et al., 2021). Long-term adherence to a gluten-free diet (GFD) is the most efficacious approach for preventing symptoms in individuals with celiac disease (Jędrusek-Golińska, 2018). The GFD includes food groups or FF products that naturally lack gluten, such as unprocessed fruits, vegetables, seafood, meat, poultry, legumes, nuts, and most dairy products (El Khoury et al., 2018). Gluten is present mainly in wheat, rye, and barley. Wheat, the most extensively grown cereal, is a fundamental component of various diets, such as the Mediterranean diet (Peñalver et al., 2023). Wheat is the sole cereal with sufficient quantities of gliadins and gluten to create gluten (Monteiro et al., 2021), leading to a gluten-free diet (GFD).

There is a high demand for gluten-free products and flour, including bakery items, pastries, cakes, desserts, ice-creams, ready meals, dairy and dairy alternatives, meat and meat alternatives, condiments, seasonings, spreads, pasta, and rice. This demand can be satisfied by a wide range of gluten-free options that utilise gluten-free cereals and pseudocereals such as rice, corn, quinoa, millet, and amaranth as their main ingredients (Bascuñán et al., 2017; El Khoury et al., 2018). Green plantain flour (GPF) is a viable option for obtaining indigestible carbs, as demonstrated by studies conducted by Garcia-Valle et al. (2019) and Fu et al. (2022). Furthermore, GPF is acknowledged for having the highest concentration of resistant starch (RS), as reported by Almanza-benitez et al. (2015) and Fu et al. (2022). Currently, resistant starch (RS) is classified into five groups: "physically inaccessible starch (RS1), resistant granules (RS2), retrograded starch (RS3), physically or chemically modified starch (RS4 – starch with non-starch bonds), and starches containing amylose-lipid complexes (RS5)" (Hasjim et al., 2013; Zaman & Sarbini, 2016). The GPF has a starch content of approximately 85%, with the remaining 15% comprising valuable nutrients such as minerals, proteins, fibre, and lipids (Gutiérrez, 2018).

Plantain (*Musa spp.*) refers to a specific category of bananas that require boiling before consumption because of their elevated starch content. The proximate composition of extant and currently marketed plantain cultivars is primarily composed of carbohydrates, with potassium being the dominating mineral (Perez-Donado et al., 2023). Plantain is a significant staple crop in tropical and subtropical locations across the globe. Within the region of sub-Saharan Africa, the consumption of bananas and plantain contributes to almost 25% of the energy requirements for a population of 70 million individuals (Honfo et al., 2022). Starch plays a crucial role in the process of making flour. The maturation phase of the fruit determines the attributes of the flour produced. Plantain flour in its raw form has significant amounts of resistant starch and dietary fibre, making it beneficial for human health (Ekafitri et al., 2022). Ripe plantain flour is rich in sugar content, making it ideal for culinary preparations that necessitate solubility, sweetness, and high energy content. According to Ekafitri et al. (2022), ripe plantain flour exhibits superior sensory qualities regarding taste and flavour compared to raw plantain flour. Additionally, it is also more easily digestible. Plantain peel flour is rich in dietary fibre and contains antioxidant compounds.

Rustagi et al. (2021) conducted a study to analyse the nutritional and functional qualities of gluten-free cereals, namely pearl millet, buckwheat, amaranth, and unripe banana flours, in comparison to wheat flour for bakery items. The study suggests that including protein-rich and high-energy gluten-free flours, together with their functional qualities, can help create composite flour and address the shortage of therapeutic gluten-free diets (Rustagi et al., 2021). Similarly, Arora et al. (2023) examined the nutritional and functional aspects of four types of GF flours: pregelatinised rice, pearl millet, common buckwheat, and soy protein isolate. The results demonstrated the potential for developing novel dishes and combinations using these raw gluten-free components. Vici et al. (2015) emphasised that while the gluten-free diet is essential for treating celiac disease and the focus is on avoiding gluten, it is also essential to assess the diet's nutritional value. In their study, Kemski et al. (2022) incorporated breadfruit (BF) and unripe plantain (UP) into gluten-free (GF) muffins. They also created a muffin using a 1:1 blend of BF and UP. These muffins were then compared to muffins made with GF rice (RI) or traditional wheat (WH) flour. The results demonstrated that the general acceptability of GF muffins was higher for both breadfruit/unripe plantain and Breadfruit suggesting their potential for commercial success.

Plantain flour serves as a dietary energy source. It offers potential benefits such as alleviating symptoms of gastrointestinal diseases, reducing blood sugar levels, and aiding in managing obesity and diabetes (Falcomer et al., 2019). Research has demonstrated that unripe plantain flours can be utilised as the primary ingredient to create gluten-free snacks that are rich in dietary fibre and have a low predicted glycemic index. These gluten-free snacks have the potential to serve as an alternative for managing weight and addressing obesity issues in both the general population and the celiac community (Flores-Silva et al., 2015). Furthermore, using unripe plantain to improve acute pancreatitis could significantly impact the treatment of diabetes and its associated complications. This suggests that unripe plantain can potentially manage kidney and liver complications from diabetes mellitus (Eleazu and Okafor, 2015). Hence, plantain has significant potential for utilisation in producing functional food products.

Materials and Method

Search Strategy

The systematic review adhered to the principles outlined in the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) (Moher et al., 2015). The search technique involves using keywords and associated phrases to locate pertinent articles and related items. The databases Medline, Pubmed, Scopus, and Cinahl Plus were utilised to create an articles database by employing different keywords. The search utilised Boolean operators (AND/OR) to combine keywords to narrow the article inquiry (Polit and Beck, 2017). In addition, the sources' references were examined to uncover other relevant resources used to expand the database of produced articles (Siegel, et al., 2020). The articles obtained for the database were carefully evaluated using specific criteria to determine their relevance to the topic of the study (Parahoo, 2014). Four databases (PubMed, Medline, Cinahl and Scopus) were explored using the following research strings:

"Green Plantain Flour OR Unripe Plantain Flour"

"Gluten Free Diet Products AND Green Plantain Flour OR Unripe Plantain Flour"

"Green Plantain Flour OR Unripe Plantain Flour AND Functional Food Products"

Details of their feedback across the database is presented in Appendix A. The feedbacks were subjected to eligibility criteria based on inclusion and exclusion criteria.

Inclusion Criteria

The inclusion criteria ensure that:

i All articles published were included in the study irrespective of the year of publication.

ii Article were limited to experimental studies/research related to GPF including the physicochemical properties.

iii All articles based on GPF or unripe plantain flour (UPF) or combined with other flour products were included in the study.

iv All articles written in English Language or available in English version were included.

v All articles that were related to the keywords were included.

Exclusion Criterial

The exclusion criteria ensure that:

i. Articles based on systematic review or other form of review, letters, short communications or book and book chapter (that is not experimental based) were excluded from the study.

ii. Articles based on flours or other ingredients other than GPF or UPF or combined with it were excluded from the study.

iii. All articles written in language other than English language or not available in English language version were excluded.

iv. All articles that were not related to the keywords were excluded.

Critiquing Tool

Critiquing is a systematic process of comprehending and evaluating the strengths and weaknesses of a publication (Jirojwong et al., 2011). Similarly, assessing the quality of a research study in relation to its intended purpose involves critical evaluation (Burns and Grove, 2011; Broomfield, 2014). The Critical Appraisal Skills Programme (CASP) tool (CASP, 2010) was used to evaluate the sourced articles in this review . The CASP is widely used to evaluate qualitative research on a specific topic (Hannes & Macaitis, 2012; Dalton et al., 2017). It is user-friendly and recommended for individuals who are new to qualitative research (Hannes et al., 2017). Thus, the review chose to utilise this tool due to the author's lack of experience criticising qualitative research. Moreover, given the instrument's proficiency in agri-food technology and health-related research, it is an ideal tool for the review.

Results and Discussion

The search was conducted on 28 November 2023 and total of 1,274 articles were identified across three of the electronic databases (Cinahl Plus returned no article from the research strings). From the PubMed database, the search with the research strings returns with a total of forty-five (45) articles and after review for suitability for the study based on inclusion and exclusion criteria, twenty-two (22) articles were selected. From the Medline database, fifty-eight (58) articles returned from the search and eight (8) articles were selected based on the inclusion and exclusion criteria. From the Scopus database, one thousand, one hundred and seventy-one (1,171) articles returned from the search and twenty-eight (28) articles were selected based on the inclusion and exclusion criteria. Therefore, a total of fifty-eight (58) articles were selected from the electronic database based on the inclusion and exclusion criteria. The references of the selected articles were further review for studies similar to the research strings and four (4) articles were selected. Further review was carried out on the selected articles (62) for duplicates and relevance to the objectives of the study and a total of thirty-four (34) articles were used for the systematic review. The selection and review process in consistent with the PRISMA-P is presented in Figure 1.

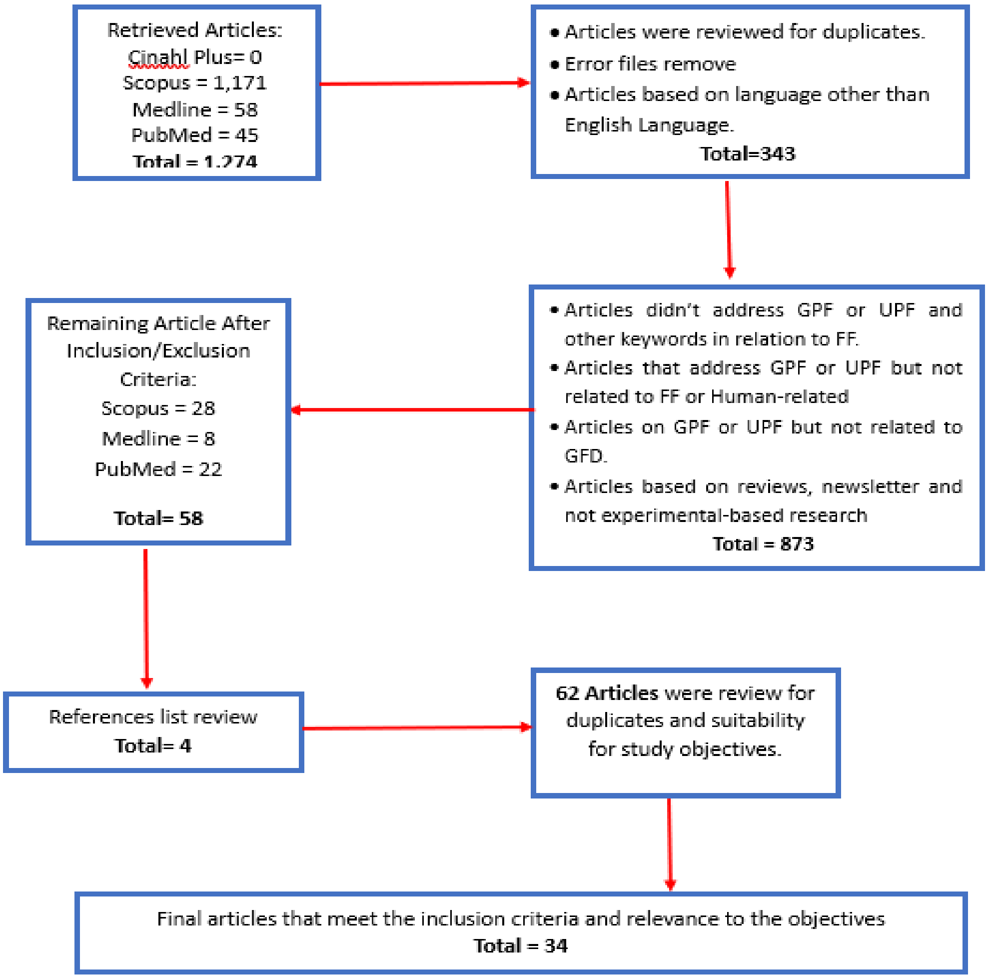

Figure 1: Selection and Review Process Based on PRISMA-P

Nutritional and Functional Properties of Composite GPF as Potential GF Diet Products

Composite baking flour mainly consists of wheat and one or more flours blended in predefined quantities. Flours derived from many native crops, including rice, sorghum, chickpea, tiger nut, and others, have demonstrated the potential to produce composite baked items (Shittu et al., 2013). The proportion of wheat flour (WF) needed to achieve a specific outcome in composite flours is greatly influenced by the quality and quantity of wheat gluten and the product's nature (Shittu et al., 2013); however, it is essential to note that composite flours can include other types of flour besides WF. In some instances, GPFs undergo modifications through various technological processes to enhance their nutritional and functional characteristics for prospective utilisation (Gutiérrez, 2018). The nutritional composition and functional profile of diverse composites and modified gluten-free flours, including wheat flour, from various parts of the world were examined and summarised in Table 2.

Table 2: Composition of Composite GPF as Potential Gluten-Free Diet Products

Authors	1	2	**3**	**4**	**5**	**6**
Composite Flour	Pure GPF	A	**B**	**C**	**D**	**E**
Proximate Composition						
Moisture (g/100 g)	10.8	30.66	1.84[a]	20.6	8.6[a]	9.17
Protein (g/100 g)	2.91	21	9.26[a]	6.3	1.0[a]	5.32
Fat (g/100 g)	0.3	3.59	35.81[a]	6.5	0.08[a]	17.03
Ash (g/100 g)	2.05	3.96	3.68[a]	1.5	0.81[a]	1.67
Fibre (g/100 g)	4.38	2.53	0.69[a]	2.0	0.36[a]	5.25
Starch (g/100 g)	78.48			57.8		
Amylose (g/100 g)	22.80			47.5	27.9[a]	
RS					85[a]	
Mineral Composition						
Ca (mg/100 g)	8.11	2.72		115.9		3.98
Mg (mg/100 g)	101.17	1.54		117.9		35.90
Fe (mg/100 g)	2.19	1.36		4.5		0.48
Zn (mg/100 g)	0.38	2.08		2.2		
K (mg/100 g)	1175.39	97.26		232.5		144.9
Na (mg/100 g)	1.27	61.87				
P (mg/100 g)	91.71	2.93				74.16

1*: Culetu et al. (2021)* ***2****:Olugbuyi et al. (2023),* ***3****: Agu & Okoli, 2014* ***4****: Udomkun et al. (2022),* ***5****: Gutiérrez (2018)* ***6****: Adegunwa et al. (2017)*

A*: Wheat: Plantain: Amaranth (60:20:20)%,* ***B****: Wheat: Beniseed: GPF (60:30:10),* ***C****: WF: GPF (90:10)* ***D:*** *Phosphated GPF* ***E****:GPF:Tiger Nut (50:50)*

[a] *Value reported in %*

Gutiérrez (2018) explored the enhancement of nutritional characteristics of plantain flour with several chemical modifications, including acetylation, carboxymethylation, methylation, oxidation, and phosphation. The phosphated plantain flour had the highest potential among the modified plantain flours. It had a moisture content of 8.6%, protein content of 1.0%, fat content of 0.08%, ash content of 0.81%, and fibre content of 0.36%. Additionally, it had a resistant starch (RS) content of almost 80%, which is significantly higher than the RS content of approximately 31% found in native plantain flour. Olugbuyi et al. (2023) demonstrated that a composite flour consisting of 60% wheat, 20% green plantain, and 20% amaranth grain exhibited the most notable levels of crude protein, potassium, and antioxidant activity. The proximate composition of a composite flour consisting of 60% wheat, 30% beniseed, and 10% GPF was shown to be better than that of a composite flour consisting of 80% wheat, 10% beniseed, and 10% GPF (Agu & Okoli, 2014). The moisture content decreased from 2.55% to 1.84%, but the protein content increased from 8.03% to 9.26%. The fat content also increased from 30.07% to 35.81%, and the ash content increased from 2.94% to 3.68%. The crude fibre content increased from 0.47% to 0.69% (Agu & Okoli, 2014). Udomkun et al. (2022) found that substituting 10% and 20% of WF with GPF enhanced proximate mineral composition. The moisture content ranged from 20.6% (GPF-10%) to 21.4% (GPF-20%), the ash content ranged from 1.4% (WF) to 1.9% (GPF-20%), and the zinc content ranged from 1.8 mg/100 g (WF) to 2.6 mg/100 g (GPF-20%). In general, GPF-10% had superior ratings in attractiveness and readiness to pay compared to the control group (WF). Adegunwa et al. (2017) compared the proximate composition between GPF and a GPF-Tiger nut flour (GPFTNF) composite at a 50:50 ratio. The composite flour composition demonstrates an enhancement in moisture content, decreasing from 10% in GPF to 9.17% in GPFTNF. Similarly, the crude protein content increases from 4.45% in GPF to 5.32% in GPFTNF. The fat content experiences a significant rise, increasing from 2.25% in GPF to 17.03% in GPFTNF. Additionally, the ash content increases from 1.33% in GPF to 1.67% in GPFTNF, while the crude fibre content increases from 3.50% in GPF to 5.25% in GPFTNF.

Oluwajuyitan et al. (2021) proposed that including multiple plant components enhances the nutritional content of flour mixes and found that the composite flour of WF: GPF: AF had a higher amount of dietary fibre due to the addition of mature GPF and amaranth flour (AF). This increase in dietary fibre has health benefits, as it helps reduce the risk of obesity and diabetes mellitus. Dietary fibre has a significant impact on the functioning of the gastrointestinal system and helps lower the incidence of obesity and diabetes mellitus (Udomkun et al., 2022; Ijarotimi et al., 2022; Oluwajuyitan et al., 2021). Protein has a crucial function in promoting growth and repairing damaged tissues. The composite flour created by Olugbuyi et al. (2023) demonstrates the potential for growth and development, due to the incorporation of amaranth flour.

Similarly, Bringas-González et al. (2022) suggests that incorporating GPF and AF into bread recipes improved the antioxidant qualities and increased the amount of dietary fibre. Including whole GPF in bread can decrease the pace at which starch is broken down, affecting the glycemic response. Udomkun et al. (2022) found that the composite bread, which contained 10% GPF as a substitute for WF, had acceptable taste and quality despite a lower protein level. Inyang and Asuquo (2016) stated that replacing around 20% of GPF with wheat flour is possible without causing any negative sensory impacts. Gutiérrez (2018) found that the original GPF had a resistant starch (RS) level of approximately 31%, consisting mainly of RS2 and RS5. On the other hand, the phosphated GPF had a higher RS content of almost 80%, constituted of RS2, RS4, and RS5. This statement is comparable to the one by Udomkun et al. (2021), which said that acid-treated plantain flour had more RS. The abundance of RS and dietary fibre in GPF renders it a favourable option as a local ingredient for creating functional food to manage diabetes (Odebode et al., 2017). Gutiérrez (2018) suggests that starch sources possessing these qualities have the potential to be utilised in the creation of functional meals. The phosphated plantain flour possesses notable characteristics that make it suitable for creating functional foods for those with celiac disease, namely in producing mold bread and cookie recipes. Adegunwa et al. (2017) observed that replacing GPF with GPF:TNF, to a greater extent, significantly improved the protein, fat, ash, and dietary fibre levels in the composite flour, which could have nutritional benefits. TNF is beneficial to GPF as it provides protein, minerals, and vitamins. It also serves as a gluten-free substitute for wheat flour and composite flour, making it a promising ingredient for food formulation (Adegunwa et al., 2017).

Conclusion

The study systematically considers the potential of GPF as a raw material for the development of GF functional food products. Review on studies on the nutritional properties reveals variation in the functional, mineral and proximate attributes of plantain cultivars which will affects its potential as raw material for functional food products. Regardless of the content in compositional properties,

1. Every cultivar of GPF has the potential of providing the GF functional food products; however, to enhance the potentiality for health-related benefit and acceptability, a carefully blend composite of GPF and other available flour is encouraged.
2. GPF alone has been used in making gluten free spaghetti with acceptable textural properties and improve RS. As a composite, GPF has been mixed with wheat flour, maize flour, chickpea flour, rice flour, soybean cake, rice brain to produce cookies, muffins, bread, biscuit and sponge cake.

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