https://doi.org/10.51745/najfnr.6.14.115-125

https://www.najfnr.com

REVIEW ARTICLE

A review of traditional grain-based complementary foods for children aged 6-23 months in selected African countries

Tafadzwa Christine Dhliwayo, Loveness Kuziwa Nyanga*, Prosper Chopera, Tonderayi Mathew Matsungo, Cathrine Chidewe

University of Zimbabwe Faculty of Science/Department of Nutrition Dietetics and Food Sciences 630 Churchill Avenue, Zimbabwe. Email: tafadzwa3743@gmail.com / nyangael@science.uz.ac.zw / pchopera@gmail.com / tmatsungo@gmail.com / nyangael@science.uz.ac.zw / cchidewe@gmail.com

Abstract

Background: Wheat and maize flour still represent the bulk ingredient in complementary foods. There is an increasing interest in traditional cereal grain-based products due to their positive health effects. The positive health benefits include; more protein and fiber content than modern grains and most are naturally gluten-free. **Aims:** To identify available traditional grain-based complementary food options used for children aged 6-23months in Africa, including the effects of various processing techniques on the nutritional value of the food products. **Material and Methods:** We searched SciELO, Google Scholar, AGORA, JSTOR, MedLine, ScienceDirect, SpringerLink, Wiley Online, and PubMed databases for the following (a) studies on the formulation of homemade or commercialized traditional grain-based complementary feeding porridges, (b) studies where traditional grains such as sorghum, finger millet, guinea millet, and pearl millet were used as the main ingredient. In addition, we evaluated the food processing techniques used, the resultant nutritional quality, and the acceptability of the product. **Results:** Thirteen eligible studies were identified. Traditional grains used frequently as complementary foods for children aged 6-23 months in Africa were pearl millet (*Pennisetum glaucum*), millet (*Panicum miliaceum),* sorghum (*Sorghum bicolor. L*), and finger millet (*Eleusine coracana*). The most common techniques to improve the nutrition content of the foods were: fermentation, germination, and addition of legumes. Additionally, minor investigations have been carried out on effectiveness of these porridges in reducing malnutrition prevalence in this age group. **Conclusions:** In overall more studies are required with the focus on investigating the development of novel strategies to improve the nutritional profiles, safety, and acceptability of traditional grain-based complementary foods. Furthermore, their effectiveness to improve nutrition status of children needs to be investigated.

Article information

***Corresponding author:** Loveness Kuziwa Nyanga, University of Zimbabwe Faculty of Science/Department of Nutrition Dietetics and Food Sciences 630 Churchill Avenue, Zimbabwe. Tel: +263 782 743 311, Email: nyangael@yahoo.com

Received: April 20, 2022
Revised: August 26, 2022
Accepted: September 20, 2022
Published: October 08, 2022

Article edited by:
- Pr. Meghit B. Khaled

Article reviewed by:
- Dr. Given Chipili
- Dr. Salome Kasimba

Keywords:
Complementary food, Infants, Traditional Grains, Africa.

1 Introduction

Complementary foods can be defined as any liquid or solid nutrient-containing foods given to young children in addition to breast milk [1]. Koletzko (2008) [2] further defined them as foods and liquids other than breast milk or infant formulas required during the second part of the first year of life for both nutritional and developmental reasons and also to enable transition from milk feeding to family foods. Adequate nutrition during infancy and early childhood is fundamental for optimum growth and development of children [1]. The "critical window" for the promotion of optimal growth, health, and behavioral development is the period from birth to two years of age [1]. World Health Organization recommends that infants should be exclusively breastfed for the first six months of life and thereafter should receive nutritionally adequate and safe complementary foods whilst breastfeeding continues up to two years of age or beyond [2]. After six months of age, breast milk is inadequate to meet the macro- and micronutrient requirements of infants [3]. In developing countries, protein-energy malnutrition is highly prevalent due to many reasons that include failure to exclusively breastfeed as well as failure to give the right amounts of nutritious complementary foods to the children [2]. Traditional grains are crops mainly originating from Africa and are usually referred to as "Orphan crops" or "Lost crops" [4]. These traditional grains include sorghum (*Sorghum bicolor*), finger millet (*Eleucine coracana*), teff (*Eragrostis tef*), white fonio (*Digitaria exilis*), black fonio (*Digitaria iburua*), pearl millet (*Pennisetum glaucum*), guinea millet (*Urochloa deflexa*) and African rice (*Oryza glaberrima*) [4]. Traditional grains have numerous positive health benefits and these are mainly due to their constituents. They contain more protein and fiber than modern grains [5], provide energy, promote satiety in drought-prone areas for communities reliant on them [6], and are naturally gluten-free [7]. Further these cereals have shown anti-oxidant properties with or without processing [8].

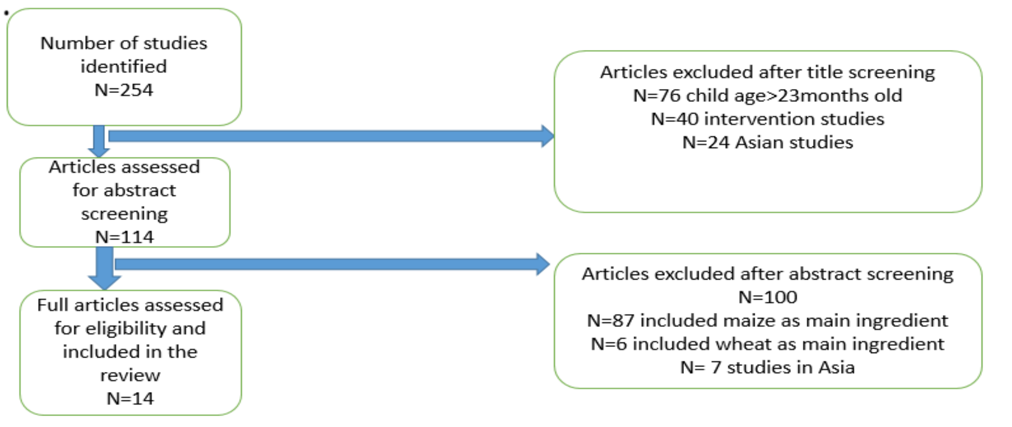

Figure 1: Search of publications related to traditional grain-based complementary foods for children aged 6-23 months in selected African countries

Diets rich in such grains are protective against non-communicable diseases such as cardiovascular diseases, some cancers as well as diabetes [9].

Traditionally, cereal-based complementary foods constitute the main source of nutrients for children aged 6-23 months in Africa[3]. Traditional grains have great advantages as crops in the world are threatened by global warming; for example, sorghum is drought-tolerant and pearl millet can be cultivated under conditions of low rainfall [4].

Over the past years, traditional grains such as finger millet and sorghum have mainly been grown for subsistence [10]. Limited attention by breeders and agronomists means yields remain worryingly low and yet they can withstand harsh conditions [11].

A stable market requires trade and commercial products from the grains, however, this in turn requires a stable supply [10].

The objective of this review paper is to summarize available evidence regarding the use of traditional grains in the production of complementary foods for children aged 6-23 months in Africa. In addition, a review of the effects of commonly used processing techniques on the nutritional profile of traditional grain-based complementary foods has been discussed.

2 Material and Methods

A search was conducted on SciELO, Google Scholar, AGORA, JSTOR, MedLine, ScienceDirect, SpringerLink, and PubMed. A population, concept, and context (PCC) framework was used to define search terms and guide screening of articles. In this study, the population group consisted of children aged between 6 and 23 months old. The concept was the phenomena of interest i.e., complementary feeding with traditional cereal grains. The context was geographical (Africa) and time-bound (studies in the last 20 years). The search syntax was therefore built using the following keywords and their synonyms: *"complementary foods+children6-23months+traditional grains+Africa.* Search techniques such as the use of Boolean operators (AND, OR, and NOT) to create a comprehensive search were applied.

The main criteria for inclusion of selected papers were: a) children aged between 6-23months; b) countries in Africa that utilize traditional grains; c) homemade and commercialized traditional complementary foods; and d) traditional grains: sorghum, finger millet, proso millet, and pearl millet. On the other hand, articles

Table 1: Traditional homemade complementary foods and main ingredients used in African countries for children aged 6-23 months

Main ingredients used	Product produced	Country	Ref
Pearl millet (*Pennisetum glaucum*), tigernut and crayfish	Flour blends	Nigeria	12
Millet (*Panicum miliaceum*), pumpkin seeds, carrots, cowpea leaves and skimmed milk powder	Nutrient-enhanced millet- based composite flour	Uganda	13
Millet (*Panicum miliaceum*), with sesame and soy	Porridge	Uganda	14
2 types of sorghum (*Sorghum bicolor. L*) and the Variety 76T1#23	Porridge gruel	Ethiopia	15
Soybean- millet, soybean- sorghum, peanut-millet, peanut sorghum, cowpea-millet, cowpea-sorghum	Complementary food	Ghana	16
Sorghum, soybean, karkade and premix	Complementary food	Ethiopia	17
Finger millet and cowpeas	Complementary food	Kenya	18
Finger millet, kidney beans, peanuts, mangoes	Porridge	Tanzania	19
Sorghum and amaranth	Complementary food	Kenya	20
Sorghum, *Adansonia digitata* fruit pulp, *Moringa oleifera* leaf powder, and *Cochlospermum tinctorium* root powder	Complementary food	Benin	21
Pearl millet (*Pennisetum glaucum*), ginger, mint and black pepper	Fermented gruel (*ben-saalga)*	Burkina Faso	22
Sorghum (*Sorghum bicolor*), groundnuts (Arachis hypogaea), mango (*Mangifera indica*) and spinach (*Cnidoscolus chayamansa*)	Complementary food	Cameron	23
Sorghum *(Sorghum bicolor*), Irish potato and groundnut	Complementary food	Nigeria	24

were excluded when: a) research papers were older than 20 years; b) studies in which intervention was undertaken for supplementary and therapeutic purposes; and c) studies where maize and wheat were used as the main grains because they are not regarded as traditional grains. Articles written in English only were considered.

All database results were exported into Mendeley where duplicates were removed. The screening process was performed in three steps; first, titles of all articles were critically screened in order to ensure that they were linked to the study topic. Secondly, the abstracts of the selected papers were screened to remove irrelevant studies. Finally, the full texts of the articles were critically analyzed and reviewed to compile the relevant information needed. This information consists of the following; author, year, product, main ingredients, methods, other ingredients, resultant nutrient value, and country. This was recorded onto a data extraction template specifically created for the study. This process was checked and audited by two independent researchers.

3 Results

Our search identified 253 records (Figure 1: Search of publications related to traditional grain-based complementary foods for children aged 6-23 months in selected African countries). We excluded 140 studies for the following reasons; 76 studied children older than our cut-off of 23 months, 40 papers were intervention studies, and 24 papers were Asian studies. The final included papers were from Nigeria (n=2), Uganda (n=2), Ethiopia (n=2), Ghana (n=1), Kenya (n=2), Tanzania (n=1), Benin (n=1), Burkina Faso (n=1), and Cameron (n=1).

A summary of the traditional homemade complementary foods and the main ingredients used in African countries for children aged 6-23 months is presented in Table 1 (Traditional homemade complementary foods and main ingredients used in African countries for children aged 6-23 months). The results show that the main ingredients used in the production of complementary food products in the selected African countries were pearl millet (*Pennisetum glaucum*), millet (*Panicum miliaceum),* sorghum (*Sorghum bicolor*), and finger millet (*Eleucine coracana*).

4 Discussion

Main grain ingredients used in the production of traditional grain-based complementary foods

Traditional grains used frequently to make complementary foods for children between 6-23 months in Africa are millet, pearl millet, sorghum, and finger millet (Table 1).

Table 2: Methods used to process the traditional grains, other ingredients used and nutrient values of the complementary foods

Traditional grain	Other ingredients used	Methods	Resultant nutrient value	Ref
Pearl millet	Tigernut and crayfish	Germination	Protein 19.88% CHO 55.57% Zinc 6.0mg Iron 11.18mg	[12]
Pearl millet	Ginger, mint and black pepper	Fermentation	Energy 30kcal/100g	[22]
Sorghum	Amaranath	Germination	Protein 14.4% Fat 6.8% Ash 2.2%	[20]
Sorghum	Groundnuts (*Arachis hypogaea*), mango (*Mangifera indica*) and spinach (*Cnidoscolus chayamansa*	Fermentation	Protein 95.15% Carbohydrate 97.17%	[23]
Sorghum	*Adansonia digitata* fruit pulp, *Moringa oleifera* leaf powder, and *Cochlospermum tinctorium* root powder	Mixing	Iron 17.4mg/100g Zinc 1.2mg/100g	[21]
Sorghum (*Sorghum bicolor*, L)	2 types of sorghum (*Sorghum bicolor*. L) and the Variety 76T1#23	Germination	Protein 12.43% CHO 72.73% Iron 9.71mg Zinc 1.93mg	[15]
Millet	pumpkin seeds, carrots, cowpea leaves and skimmed milk powder	Germination Roasting	Protein 15.3% CHO 70.7% Iron 3.6mg Zinc 4.2mg Vitamin A 641IU	[13]
Millet	Soybean	Mixing	Energy 235 kcal Protein 9.7g Fat 4.4g	[16]
Sorghum	Soybean	Mixing	Energy 216 kcal Protein 9.8g Fat 4.0g	[16]
Millet	Peanut	Mixing	Energy 249 kcal Protein 8.4g Fat 7.9g	[16]
Sorghum	Peanut	Mixing	Energy 231 kcal Protein 8.5g Fat 7.5g	[16]
Millet	Cowpea	Mixing	Energy 222 kcal Protein 8.1g Fat 2.2g	[16]
Sorghum	Cowpea	Mixing	Energy 203 kcal Protein 8.2g Fat 1.7g	[16]
Sorghum	Soybean, karkade and premix	Mixing	Energy 425.51 kcal Iron 7.46mg Zinc 3.8mg	[16]
Finger millet	Cowpeas	Germination	Protein 7.29g	[18]

Table 3: The advantages and disadvantages of adding other ingredients to traditional grains during processing of complementary foods

Traditional grains	Legumes and other ingredients	Advantages	Disadvantages	Ref
Pearl millet	Tigernut and crayfish	- Tigernut has high levels of fiber, protein, carbohydrates, natural sugars (Soluble Glucose), the very high fiber improves the nutrient content, palatability, and content combined with a delicious taste make [39]	- High levels of fat in tigernut causes short shelf life	[12]
Sorghum	Irish potato and groundnut	- Irish potatoes are a rich source of protein, carbohydrates, minerals and vitamins [40] - Groundnuts are a rich source of oil and proteins [41]	- The complementary food produced had low mineral content due to the legume used with low mineral content	[24]
Millet	pumpkin seeds, carrots, cowpea leaves and skimmed milk powder	- Skimmed milk powder is rich in protein with balanced essential amino acids and high digestibility [44]	- Cowpea leaves have anti-nutritional factors [45] - Skim milk has low natural fat soluble vitamins [54]	[13]
Millet, sorghum	Soybean, peanut and cowpea	- Soybean is cholesterol free and is lactose free [47] - Cowpea is a low cost of proteins, iron and folates [48]	- Soybean can cause low shelf life because of the high fat content [66]	[16]
Sorghum	Soybean, karkade and premix	- Soybean is a good source of protein [49] - Karkade lowers cholesterol levels [50]	- Soybean reduces shelf life of the product [51]	[17]
Finger millet	Cowpeas	- Cowpeas is a good source of protein [52, 53]	- Cowpeas has antinutrients [54, 55]	[18]
Sorghum	Amaranath	- Amaranth contains plenty of fiber, protein and micronutrients [56]	- Amaranth contains antinutrients; oxalates and nitrates if not properly cooked [56]	[20]
Finger millet	Kidney beans, peanuts, mangoes	- Kidney beans are a good source of protein [57] - Mangoes are rich in minerals and anti-oxidants [58]	- Peanuts have a high quantity of saturated fats [59] - Dried mangoes have high sugar content [60]	[19]
Millet	Sesame and soy	- Soybeans are rich in protein and rich source of manganese, phosphorus and good source of iron and vitamin K [61, 62] - Sesame are good sources of calcium and B vitamins [63]	- Soybeans contain anti-thyroid compounds that disrupts the activity of the thyroid gland and results in goiter [64] - Sesame have higher oil content leading to reduced shelf life of the complementary food [65, 66]	[14]
Pearl millet	Ginger, mint, pepper and black pepper	- Ginger helps lower cholesterol levels [67] - Black pepper improves blood sugar control [68, 69]	- Excessive black pepper intake leads to burning sensations in the throat [86] - Mint causes heartburn [71]	[22]
Sorghum	Groundnuts (*Arachis hypogaea*), mango (*Mangifera indica*) and spinach (*Cnidoscolus chayamansa*)	- Groundnuts are rich in protein and regulates blood glucose levels [72] - Mangoes contain immune boosting nutrients [73, 74] - Spinach promotes digestive regularity [75]	- Groundnuts may cause allergic reactions [76, 77]	[23]

The complementary foods, as shown in Table 1, which are primarily made from traditional grains, are frequently mixed with legumes such as groundnuts and beans to improve the content of the limiting nutrients in the cereal grains. The use of germinated sorghum flour in the formulation of complementary foods provides gruels of low viscosity and high energy and nutrient density, therefore, potentially increasing nutrient bioavailability [15]. Most of the complementary foods were from germinated millets and these were more acceptable and popular than those where sorghum was the main ingredient [13].

Common processing techniques of complementary foods in Africa and the effect on nutrient content

Different methods have been used to process the traditional grain-based complementary foods for children aged between 6-23 months in Africa. Fermentation, germination, steaming and toasting have been applied either alone or in combination at single temperatures or varying temperatures [25].

In studies that have used millet, the first step is always to clean and sort [15], remove any foreign materials from the millet and

make the grain appropriate for eating without any dirt. Pearl millet was germinated for 72 hours and then fermented for 48 hours [12]. The results showed that an acceptable complementary food can be developed which to meet the nutritional requirements of children between 6-24 months [2].

Food fermentation has been shown to effectively increase the nutritional composition of foods as well as decrease the levels of anti-nutritional factors (ANFs) and toxic constituents [26, 27]. Fermentation constitutes an important process that helps to lower the content of anti-nutrients (phytates, tannins, and polyphenols) of cereal grains. Fermentation can activate several endogenous enzymes which reduce anti-nutritional factors [27]. Fermentation activates starch hydrolyzing enzymes such as alpha-amylase and maltase which degrade starch into maltodextrins and simple sugars[28]. The process of fermentation also increases the bioavailability of calcium, phosphorous, and iron likely due to the degradation of oxalates and phytates that are complex with minerals. thereby reducing their bioavailability [28]. Fermentation also improves organoleptic properties as well as extends the shelf life of food products [29, 30].

Germination has long been used to improve the functional properties [31] and nutritional value [32] of sorghum flour. In another study, Tizazu *et al.* [15] germinated sorghum grains at room temperature for 48 hours. This resulted in gruels of low viscosity, high energy, and nutrient density, therefore, potentially increasing nutrient intake in this age group. Kim *et al.* [33] outlined that germination increases various vitamins present in cereals and legumes such as tocopherols (α-, β-, and γ-tocopherols), riboflavin (Vitamin B_2), and total niacin (Vitamin B_3) due to synthesis of these vitamins by the new sprouts. It has been hypothesized that the remarkable increase in phytase activity during germination helps reduce phytic acids, which bind minerals subsequently leading to increased mineral availability [34].

Disruption of food matrices embedding various minerals helps to increase the bioavailability of minerals making fermentation and germination key in improving weaning and complementary foods for children, especially in regions where diet is predominantly plant-based [35]. In one study that used germination followed by roasting, millet was germinated for 1-2 days and then roasted [13] resulting in 15.3% protein content and iron content of 3.6mg/100g. Several studies have shown that germination improves the nutritive value of millet over the ungerminated seeds [36]. Germination in addition to soaking and roasting has been found to decrease the levels of antinutrients present in the grain and maximize the levels of some utilizable nutrients [37].

In another study, finger millet was blended with precooked cowpea powder [18]. This resulted in increased protein content and protein digestibility in the flour from 6 to 39%. Technologies such as germination, fermentation, and cooking are simple and inexpensive and have been practiced for many years by communities in developing countries to process traditional grains. A summary of processing methods and nutrient content for complementary foods is shown in Table 2. The 13 studies analyzed the nutrient content of the resultant complementary food though not all nutrients were analyzed in all studies (Table 2). From nutrient analyses, it is shown that germination, fermentation, or a combination of the techniques give a higher protein content to the resultant porridge as compared to the use of non-germinated or fermented grain. In addition, when pearl millet was germinated at room temperature to make flour blends for complementary foods, protein content was 19.88%, carbohydrates 55.57%, zinc 6.0mg/100g, and iron 11.18mg/100g [12].

When sorghum was steamed and toasted it resulted in the following levels of nutrients; protein level of 12.43%, carbohydrates 72.73%, iron 9.71mg/100g, and zinc 1.93mg/100g [15]. Steaming and toasting improved the texture of the final product and its nutritional value due to the temperature and time combination. However, the nutritional value was less than that of the germinated process.

When sorghum was germinated it resulted in protein content of 14.4%, ash 2.2%, and fat 6.8% [20]. In another study, pearl millet was treated with water and heat before grinding (conditioning) and the effect was that it met the protein needs of children between 6 months and 2 years by increasing the protein content from 7.27 to 7.85%. Germination of finger millet resulted in an iron level of 21.1mg/100g and protein digestibility of 76% [19].

Roasting is a common processing step as it improves the taste of the final complementary food [14]. When millet was roasted it resulted in a protein level of 13.18%, carbohydrates 63.4%, iron 100.5mg/100g, and zinc 1.67mg/100g [14]. In contrast, when the millet was germinated and roasted, protein content was 15.3%, carbohydrates 70.7%, iron 3.6mg/100g, zinc 4.2mg/100g, and Vitamin A 641µg/100g [13]. There was an increase in protein and carbohydrate content. The much lower micronutrient levels could have been due to a shorter germination time or less than optimal germination conditions e.g., too low or too high temperature. Sorting and cleaning of millet grain had a higher protein content, compared to when it was germinated and roasted [14].

In another study by Tatala *et al.* [19], finger millet and kidney beans were initially soaked for 3 and 8 hours respectively and then left to germinate for 48 hours at 30°C and 80% relative humidity, washed, and then solar dried for three days. The solar-dried sprouts were then milled into fine flour and mixed in proportions with roasted ground peanuts, kidney beans, and solar-dried mashed mango puree. The mixtures were mixed in proportions of 75% finger millet, 10% peanuts, 10% kidney beans, and 5% mango (on a dry weight basis) [19]. Bioavailability of iron increased from 0.75 to 1.25mg/100g, viscosity was significantly raised by 12% and phytate concentration was reduced from 4.5 to 4.1mg/g [19].

The review showed that adding other ingredients such as legumes improved the nutrient content of complementary foods. Addition of soybeans and peanuts was more advantageous for nutrient availability through the shelf life of the product was minimized. However, the technique of adding common allergens such as nuts may not be possible in populations with peanut allergy. Overall, complementary foods made from traditional grains appear to have higher acceptability when formulated with the addition of other ingredients compared to when formulated from a single cereal. This could be due to improved sensory qualities (taste, color, and flavor) and physicochemical properties such as rheology however, more specific studies investigating factors affecting acceptability are required. The type of grain also appears to influence acceptability as most of the complementary foods from millets were more acceptable and popular than those where sorghum was the main ingredient [13]. This has some implications for novel food product development as food scientists must ensure that addition of other ingredients must be informed by existing and upcoming scientific evidence on their effects on nutritional qualities and physicochemical properties and find ways of increasing acceptability of less popular grains.

The types of legumes and other ingredients added to the traditional grains and their advantages and disadvantages have been outlined in Table 3.

Unlike in developing countries, the production of complementary foods in developed countries is more controlled, standardized, and regulated, due to improved technologies, high market demand, and government support [78]. Innovative products are also produced at a much faster pace due to continuous advances in food product development. In Europe, the recipes are based on five major staples that are locally available. These five are teff, maize, wheat, sorghum, and barley [79]. In Europe however, there is high inter-country variation in solid food offered during the complementary feeding period mainly due to the different local food traditions [80]. In England, baby rice is the most common (74%) first food offered to infants [81], whereas in Sweden for example, potatoes, carrots, and sweet corn, or products made by these ingredients, are more commonly offered as the first foods [82]. The latter appears to be more micronutrient dense. In Italy, in a national survey conducted in 2000, fruit (73.1%) and cereals (63.9%), gluten-free 52.2%, with gluten 11.7% were the first solid foods used for most infants [83]. The common factor concerning complementary foods in Africa, Asia, and Europe is the influence of local traditions in selecting the different combinations. The differences mainly arise from the nutrient content with complementary feeds from developed countries being more micronutrient dense than those from developing countries.

In the Asia Pacific region foods are often given as the first choice, complementary foods comprise rice products (flour, barn, and cake), wheat flour, and roasted soy flour. In the Islamic Republic of Iran for example, the complementary foods include pudding (*fereny*) which consists of rice flour, sugar, and milk. The nutrient content is 107kcal/100g for energy density, protein 3-5g/100g, and fat 1g/100g. *Shir berenge* is another complementary food in the Islamic Republic of Iran which consists of rice and milk, the nutrient content is 67kcal/100g, protein 2-5g/100g, and fat 2-5g/100g. *Harireh badam* is a complementary food in the Islamic Republic of Iran that consists of almond, rice flour, and sugar, with nutritional value being 60 kcal/100 g, 3-5 g/100g, and 2-5 g/100 g of fat [84]. This indicates that in Iran the main ingredient of their complementary food is rice and the nutritional value appears to be lower compared to the traditional grain-based complementary foods in Africa.

5 Conclusions

The study found out that the most commonly used traditional grains for production of complementary foods for children aged 6-23 months in Africa were millet (*Panicum miliaceum*), pearl millet (*Pennisetum glaucum*), sorghum (*Sorghum bicolor. L*) and finger millet (*Eleusine coracana*). The most common processing techniques which had positive effects on the nutrients were fermentation and germination. Addition of legumes such as ground nuts and soybeans also improved the nutritional content of the complementary foods, especially the iron and zinc content. Conversely, very little investigation has been carried out on effectiveness of these porridges in reducing malnutrition prevalence in this age group. Overall, there is need for future studies to focus on investigating the development of novel strategies to improve the nutritional profiles, safety, and acceptability of traditional grain-based complementary porridges which might lead to commercialization.

Source(s) of support: The Government of Zimbabwe through The Ministry of Higher and Tertiary Education, Science and Technology Development "Future Grains for Africa Project" funds this research.

Acknowledgment (if applicable): Authors would like to thank the University of Zimbabwe for allowing us to carry out this review article. We thank Professor. S. Mukanganyama for his technical input during the process of writing this review manuscript.

Author Contribution: T.C.D conceived the study, and undertook the literature research. All authors participated in designing the study. All authors performed the data analysis, prepared, reviewed, and drafted the manuscript. All authors approved the final version before submission. All authors have read and agreed to the published version of the manuscript.

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

References

[1] Treche, S. (2002). Complementary foods in developing countries: importance, required characteristics, constraints and potential strategies for improvement. Proceedings of the International Colloquium.132–148. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers13-12/010034493.pdf

[2] Fewtrell, M. (2008). 2.4 complementary foods. *Pediatric Nutrition in Practice*, 102-105. https://doi.org/10.1159/000155444

[3] Ijarotimi, S.O., & Keshinro, O.O. (2013). Determination of nutrient composition and protein quality of potential complementary foods formulated from the combination of fermented popcorn, African locust, and bambara groundnut seed flour. *Polish Journal of Food & Nutrition*

Sciences, *63* (3), 155–166. https://doi.org/10.2478/v10222-012-0079-z

[4] Taylor, J.R.N. Traditional African Grains. In: Traditional Grains for Low Environmental Impact and Good Health, Seminar/Workshop Organised by MISTRA and IFS, Gothenburg; 2008:24-27

[5] Hassan, Z. M., Sebola, N.A., & Mabelebele, M. (2021). The nutritional use of millet grain for food and feed: a review. *Agriculture & Food Security*, *10* (16), 1–14. https://doi.org/10.1186/s40066-020-00282-6

[6] Saleh, A.S.M., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet Grains: Nutritional Quality, Processing, and Potential Health Benefits. *Comprehensive Reviews in Food Science and Food Safety*, *12* (3), 281-295. https://doi.org/10.1111/1541-4337.12012

[7] Drub, T.F., Garcia, F., Carolina, A., Solera, L., & Capriles, V.D. (2020). Sorghum, millet and pseudocereals as ingredients for gluten-free whole-grain yeast rolls. *International Journal of Gastronomy and Food Science*, *23*, 100293. https://doi.org/10.1016/j.ijgfs.2020.100293

[8] Banwo, K., Asogwa, F.C., Ogunremi, O.R., Adesulu-dahunsi, A., & Sanni, A. (2021). Nutritional profile and antioxidant capacities of fermented millet and sorghum gruels using lactic acid bacteria and yeasts. *Food Biotechnology*, *35* (3), 199-220. https://doi.org/10.1080/08905436.2021.1940197

[9] Taylor, J. R. N., & Emmambux, M. N. SPECIAL SECTION: Molecular Diversity and Health Benefits of Carbohydrates from Cereals and Pulses Developments in Our Understanding of Sorghum Polysaccharides and Their Health Benefits. In: Copeland, L, ed. Cereal Chemistry; 2010: 263-271.

[10] Standing, M., & Taylor, J. (2012). An Introduction to Traditional Grains. *Swedish Institute for Food and Biotechnology*, 2012

[11] Qaim, Q. (2020). Role of New Plant Breeding Technologies for Food Security and Sustainable Agricultural Development. *Applied Economic Perspective Policy*, *42* (2), 129–150. https://doi.org/10.1002/aepp.13044

[12] Awogbenja, M. D., Ndife, J., Daniel, B. A & Zakka, A. K. (2020). Production and Evaluation of Complementary food From Blends of Pearl Millet (*Pennisetum Glaucum*), Tigernut (*Cyperus Esulentus* L) and Crayfish (*Procambarus Clarkii*). *FUDMA Journal of Agriculture and Agricultural Technology, 6* (1), 30-41.

[13] Tumwine, G., Atukwase, A., Tumuhimbise, G. A., Tucungwirwe, F., & Linnemann, A. (2019). Production of nutrient-enhanced millet-based composite flour using skimmed milk powder and vegetables. *Food Science & Nutrition.*, *7* (1), 22–34, https://doi.org/10.1002/fsn3.777

[14] Nassanga, P., Okello-Uma, I., & Ongeng, D. (2016). Development of a Millet-Sesame-Soy complementary food composite for rural communities. *RUFORUM Working Document Series*, *14* (2), ISSN 1607-9345. https://www.ruforum.org/sites/default/files/Nassanga%20Prossy.pdf

[15] Tizazu, S., Urga, K., & Ababa, A. (2010). Improvement of energy and nutrient density of sorghum-based complementary foods using germination. *African Journal of Food, Agriculture Nutrition and Development, 10*(8). https://doi.org/10.4314/ajfand.v10i8.60875

[16] Suri, D.J., Tano-Debrah, K., & Ghosh, S.A. (2014). Optimization of the nutrient content and protein quality of cereal-legume blends for use as complementary foods in Ghana. *Food and Nutrition Bulletin, 35* (3), 372–381. https://doi.org/10.1177/156482651403500309

[17] Keyata, E.O., Tola, Y.B., Bultosa, G., & Forsido, S.F. (2021). Optimization of nutritional and sensory qualities of complementary foods prepared from sorghum, soybean, karkade and premix in Benishangul - Gumuz region, Ethiopia. *Heliyon*, *7* (9), e07955. https://doi.org/10.1016/j.heliyon.2021.e07955

[18] Syeunda, C. O., Anyango, J. O., Faraj, A. K., & Kimurto, P. K. (2021). In vitro protein digestibility of finger millet complementary porridge as affected by compositing precooked cowpea with improved malted finger millet. *Journal of Food Science and Technology*, *58*(2), 571–580. https://doi.org/10.1007/s13197-020-04569-1

[19] Tatala, S., Ndossi, G., Ash, D., & Mamiro, P. (2007). Effect of germination of finger millet on nutritional value of foods and effect of food supplement on nutrition and anaemia status in Tanzanian children. *Tanzania Health Research. Bulletin*, *9*(2), 77–86. https://doi.org/10.4314/thrb.v9i2.14308

[20] Okoth, J. K., Ochola, S. A., Gikonyo, N. K., & Makokha, A. (2017). Development of a nutrient-dense complementary food using amaranth-sorghum grains. *Food Science & Nutrition*, *5* (1), 86–93. https://doi.org/10.1002/fsn3.367

[21] Affonfere, M., Chadare, F. J., Fassinou, F.T.K., Talsma, E. F., Linnemann, A. R., & Azokpota, P. (2021). A complementary food supplement from local food ingredients to enhance iron intake among children aged 6–59 months in Benin. *Food Science & Nutrition*, *9* (7), 3824–3835. https://doi.org/10.1002/fsn3.2358

[22] Tou, E.H., Guyot, J.P., Mouquet-Rivier, C., Rochette, I., Counil, E., Traore, A.S., & Treche, S. (2006). Study through surveys and fermentation kinetics of the traditional processing of pearl millet (Pennisetum glaucum) into ben-saalga, a fermented gruel from Burkina Faso. *International Journal of Food Microbiology*, *106* (1), 52–60. https://doi.org/10.1016/j.ijfoodmicro.2005.05.010

[23] Oumarou, H., Ejoh, R., Ndjouenkeu, R & Tanya, A. (2005). Nutrient content of complementary foods based on processed and fermented sorghum, groundnut, spinach, and mango. *Food and Nutrition Bulletin*, *26* (4), 385–392. https://doi.org/10.1177/156482650502600408

[24] Adegbanke, O.R., Dada, T.A., Akinola, S.A., & Akintuyi, T. (2018). Physicochemical and sensory qualities of complementary meal made from sprouted and unsprouted sorghum, Irish potato and groundnut. *Food Science & Nutrition*, *6* (2), 307–317. https://doi.org/10.1002/fsn3.556

[25] Hotz, C., & Gibson, R.S. (2007). Traditional food-processing and preparation practices to enhance the bioavailability of micronutrients in plant-based diets. *The Journal of Nutrition*, *137* (4), 1097–1100. https://doi.org/10.1093/jn/137.4.1097

[26] Omotola, F.O., Olufunke O. E., Adenike O. O., Samson A. O., & Oluwatosin A. I. (2017). Effects of fermentation on proximate composition, mineral profile and antinutrients of tamarind (*Tamarindus indica* L.) seed in the production of daddawa-type condiment. (2017). *LWT - Food Science & Technology*, *90*, 455-459. https://doi.org/10.1016/j.lwt.2017.12.064

[27] Adebiyi, J.A., Kayitesi, E., Adebo, O. A., Changwa, R., & Njobeh, P.B. (2019). Food fermentation and mycotoxin detoxification: An African perspective. *Food Control*, *106*, 106731. https://doi.org/10.1016/j.foodcont.2019.106731

[28] Osman, M.A. (2011). Effect of traditional fermentation process on the nutrient and antinutrient contents of pearl millet during preparation of Lohoh. *Journal of Saudi Society of Agricultural Sciences*, *10* (1), 1–6. https://doi.org/10.1016/j.jssas.2010.06.001

[29] Chaves-López, C., Serio, A., Grande-Tovar, C. D., Cuervo-Mulet, R., Delgado-Ospina, J., & Paparella, A. (2014). Traditional Fermented Foods and Beverages from a Microbiological and Nutritional Perspective: The Colombian Heritage. *Comprehensive Revies in Food Science and Food Safety, 13* (5), 1031–1048. https://doi.org/10.1111/1541-4337.12098

[30] Li, S., Tayie, F. A. K., Young, M.F., Rocheford, T., & White, W.S. (2007). Retention of provitamin A carotenoids in high β-carotene maize (*Zea mays*) during traditional African household processing. *Journal of Agricultural and Food Chemistry, 55* (26), 10744–10750. https://doi.org/10.1021/jf071815v

[31] Elkhalifa, A. E. O., & Bernhardt, R. (2010). Influence of grain germination on functional properties of sorghum flour. *Food Chemistry, 121* (2), 387–392. https://doi.org/10.1016/j.foodchem.2009.12.041

[32] Wu, F., Yang, N., Touré, A., Jin, Z., & Xu, X. (2013). Germinated Brown Rice and Its Role in Human Health. *Critical Reviews in Food Science & Nutrition, 53* (5), 451–463. https://doi.org/10.1080/10408398.2010.542259

[33] Kim, H. Y., Hwang, I. G., Kim, T. M., Woo, K. S., Park, D. S., Kim, J. H., Kim, D. J., Lee, J., Lee, Y. R., & Jeong, H. S. (2012). Chemical and functional components in different parts of rough rice (*Oryza sativa* L.) before and after germination. *Food Chemistry*, *134*(1), 288–293. https://doi.org/10.1016/j.foodchem.2012.02.138

[34] Luo, Y.W., Xie, W.H., Jin, X.X., Wang, Q., & He, Y.J. (2014). Effects of germination on iron, zinc, calcium, manganese, and copper availability from cereals and legumes. *CYTA - Journal of Food*, *12* (1), 22–26. https://doi.org/10.1080/19476337.2013.782071

[35] Asres, D.T., Nana, A., & Nega, G. (2018). Complementary feeding and effect of spontaneous fermentation on anti-nutritional factors of selected cereal-based complementary foods. *BMC Pediatrics*, *18*(1), 1–9. https://doi.org/10.1186/s12887-018-1369-3

[36] Correia, I., Nunes, A., Barros, A. S., & Delgadillo, I. (2008). Protein profile and malt activity during sorghum germination. *Journal of the Science of Food and Agriculture, 88* (15), 2598-2605. https://doi.org/10.1002/jsfa.3348

[37] Badau, M.H., Nkama, I., & Jideani, I.A. (2005). Phytic acid content and hydrochloric acid extractability of minerals in pearl millet as affected by germination time and cultivar. *Food Chemistry*, *92* (3), 425–435. https://doi.org/10.1016/j.foodchem.2004.08.006

[38] Correia, I., Nunes, A., Barros, A. S. & Delgadillo, I. (2010). Comparison of the effects induced by different processing methods on sorghum proteins. *Journal of Cereal Science*, *51* (1), 146–151. https://doi.org/10.1016/j.jcs.2009.11.005

[39] Llavata, B., Albors, A., & Martin-esparza, M.E. (2019). High Fibre Gluten-Free Fresh Pasta with Tiger Nut, Chickpea and Fenugreek: Technofunctional, Sensory and Nutritional Properties. *Foods, 9* (1), 11-. https://doi.org/10.3390/foods9010011

[40] Ikanone, C. E. O., & Oyekan, P.O. (2014). Effect of Boiling and Frying on the Total Carbohydrate, Vitamin C and Mineral Contents of Irish (*Solanun tuberosum*) and Sweet (*Ipomea batatas*) Potato Tubers. *Nigerian Food Journal*, *32* (2), 33–39. https://doi.org/10.1016/S0189-7241(15)30115-6

[41] Adeyeye, A., & State, O. (2017). Chemical evaluation of food value of groundnut (Arachi hypogaea) seeds Chemical evaluation of food value of groundnut (Arachi hypogaea) seeds. *American Journal of Food and Nutrition, 2* (3), 55–58. https://doi.org/10.5251/ajfn.2012.2.3.55.57

[42] Lemos de, M. F., O. Sigueyuki, S. C., Alves, M. M., Silva, R.S., Augusto, M. G., & Denis, P.N. (2004). Grain yield and seed quality of soybean selected for high protein content.

Pesquisa Agropecuaria Brasileira, 39 (5), 445–450. https://doi.org/10.1590/s0100-204x2004000500006

[43] Esteves, E. A., Martino, H. S. D., Oliveira, F. C. E., Bressan, J., Costa, N. M. B. (2010). Chemical composition of a soybean cultivar lacking lipoxygenases (LOX2 and LOX3). *Food Chemistry*, *122* (1), 238–242. https://doi.org/10.1016/j.foodchem.2010.02.069

[44] Tumwine, G., Atukwase, A., Tumuhimbise, G.A., Tucungwirwe, F., & Linnemann, A. (2019). Production of nutrient-enhanced millet-based composite flour using skimmed milk powder and vegetables. *Food Science & Nutrition*, *7*(1), 22–34, https://doi.org/10.1002/fsn3.777

[45] Owade, J.O., Abong, G., Okoth, M., & Mwang, A.W. (2020). A review of the contribution of cowpea leaves to food and nutrition security in East Africa. *Food Science and Nutrition, 8*, 36–47. https://doi.org/10.1002/fsn3.1337

[46] Musara, C., & Nyagura, M. (2017). Skimmed milk as a determinant of vitamin A deficiency Skimmed milk as a determinant of vitamin A deficiency. *South African Journal of Clinical Nutrition*, *1* (1), 1–3. https://doi.org/10.1080/16070658.2017.1237454

[47] Ramdath, D. D., Padhi, E. M. T., Sarfaraz, S., Renwick, S., & Duncan, A.M. (2017). Beyond the Cholesterol-Lowering Effect of Soy Protein: A Review of the Effects of Dietary Soy and Its Constituents on Risk Factors for Cardiovascular Disease. *Nutrients*, *9*, 324-348. https://doi.org/10.3390/nu9040324

[48] Affrifah, N. S., Phillips, R.D., & Saalia, F. K. (2021). Cowpeas: Nutritional profile, processing methods and products. *Legume Science*, *131*, 1–12. https://doi.org/10.1002/leg3.131

[49] Mitra, P., & Tavade, P. (2022). Effect of whey and soy proteins fortification on the textural and rheological properties of value-added yogurts. *Applied Food Research*, *2*, 1-6, https://doi.org/10.1016/j.afres.2022.100195

[50] Keyata, E. O., Tola, Y.B., Bultosa, G., & Forsido, S. F. (2020). Proximate, mineral, and anti-nutrient compositions of underutilized plants of Ethiopia: Figl (Raphanus sativus L.), Girgir (Eruca sativa L) and Karkade (Hibiscus sabdariffa): implications for in-vitro mineral bioavailability. *Food Research International*, *20*, 963-969. https://doi.org/10.1016/j.foodres.2020.109724

[51] Alemayhu, A., Admassu, S., & Tesfaye, B. (2019). Shelf-life prediction of edible cotton, peanut and soybean seed oils using an empirical model based on standard quality tests Shelf-life prediction of edible cotton, peanut and soybean seed oils using an empirical model based. *Cogent Food & Agriculture*, *5* (1). https://doi.org/10.1080/23311932.2019.1622482

[52] Jayathilake, C., Visvanathan, R., Deen, A., & Bangamuwage, R. (2018). Cowpea: an overview on its nutritional facts and health benefits: Nutritional and Health Properties of Cowpea. *Journal of the Science of Food and Agriculture*, *98* (13), 4793-4806. https://doi.org/10.1002/jsfa.9074

[53] Cooper, D., Doucet, L., & Pratt, M. (2007). Understanding 'appropriateness' in multinational organizations. *Journal of Organizational Behaviour*, *28* (3), 303–325. https://doi.org/10.1002/job.440

[54] Dakora, F.D., & Belane, A.K. (2019). Evaluation of Protein and Micronutrient Levels in Edible Cowpea (Vigna Unguiculata L. Walp.). *Frontiers in Sustainable Food Systems*, *3* (70), 1–10. https://doi.org/10.3389/fsufs.2019.00070

[55] Affrifah, N. S., Phillips, R.D., & Saalia, F. K. (2021). Cowpeas: Nutritional profile, processing methods and products. *Legume Science*, *131*, 1–12. https://doi.org/10.1002/leg3.131

[56] Peiretti, P. G. (2018). Amaranth in animal nutrition: A review. *Livestock Research for Rural Development, 30* (5). http://www.lrrd.org/lrrd30/5/peir30088.html

[57] Sarker, A., Chakraborty, S., & Roy, M. (2020). Dark red kidney bean (Phaseolus vulgaris L.) protein hydrolysates inhibit the growth of oxidizing substances in plain yogurt. *Journal of Agriculture and Food Research, 2*, 100062. https://doi.org/10.1016/j.jafr.2020.100062

[58] Kumar, M., Saurabh, V., Tomar, M., Hasan, M., Changan, S., Sasi, S., Maheshwari, C., Prajapati, U., Singh, S., Prajapat, R. K., Dhumal, S., Punia, S., & Amarowicz, R., & Mekhemar, M. (2021). Mango (Mangifera indica L.) Leaves: Nutritional Composition. *Antioxidants*, *10* (2), 299. https://doi.org/10.3390/antiox10020299

[59] Griel, A.E., Eissenstat, B., Juturu, V., Hsieh, G., & Kris-etherton, P.M. (2004). Improved Diet Quality with Peanut. *Journal of the American College of Nutrition, 23* (6), 660-668. https://doi.org/10.1080/07315724.2004.10719408

[60] Zafar, T. A., & Sidhu, J.S. "Composition and Nutritional Properties of Mangoes. In Siddiq, M., Brecht, J. K., & Sidhu, J.S, ed. *Handbook of Mango Fruit: Production, Postharvest Science, Processing Technology and Nutrition. John Wiley & Sons Ltd;* 2017: 217–236. https://doi.org/10.1002/9781119014362.ch11

[61] Biel, W., Gawęda, D., Jaroszewska, A., & Hury, G. (2018) Content of minerals in soybean seeds as influenced by farming system, variety. *Journal of Elementology, 23* (3), 863-873. https://doi.org/10.5601/jelem.2017.22.3.1483

[62] Alamu, E. O., Therese, G., Mdziniso, P., & Bussie, M.D. (2017). Assessment of nutritional characteristics of products developed using soybean (*Glycine max* (L.) Merr.) pipeline and improved varieties *Cogent Food &*

Agriculture, *3*, (1), 1-12. https://doi.org/10.1080/23311932.2017.1398042

[63] Namiki, M. (2013). Nutraceutical Functions of Sesame: A Review Nutraceutical Functions of Sesame. (2007). *Critical Reviews in Food Science and Nutrition, 47* (7), 651-673. https://doi.org/10.1080/10408390600919114

[64] Hüser, S., Guth, S., Joost, H. G., Soukup, S. T., Köhrle, J., Kreienbrock, L., Diel, P., Lachenmeier, D. W., Eisenbrand, G., Vollmer, G., Nöthlings, U., Marko, D., Mally, A., Grune, T., Lehmann, L., Steinberg, P., & Kulling, S. E. (2018, August 21). Effects of isoflavones on breast tissue and the thyroid hormone system in humans: a comprehensive safety evaluation. *Archives of Toxicology, 92*(9), 2703–2748. https://doi.org/10.1007/s00204-018-2279-8

[65] Abbas, S., Sharif, M. K., Sibt-e-abbas, M., Teferra, T.F., Sultan, M. T., & Anwar, M. J. (2022). Nutritional and Therapeutic Potential of Sesame Seeds. *Journal of Food Quality*, 2022, 1-9. https://doi.org/10.1155/2022/6163753

[66] Gouveia, L. D. V., Cardoso, C. A., De Oliveira, G. M. M., Rosa, G., & Moreira, A. S. B. (2016). Effects of the Intake of Sesame Seeds (Sesamum indicum L.) and Derivatives on Oxidative Stress: A Systematic Review. *Journal of Medicinal Foods*, *19* (4), 337–345. https://doi.org/10.1089/jmf.2015.0075

[67] Fuhrman, B., Rosenblat, M., Hayek, T., Coleman, R., & Aviram, M. (2014). Ginger Extract Consumption Reduces Plasma Cholesterol, Inhibits LDL Oxidation and Attenuates Development of Atherosclerosis in Atherosclerotic, Biochemical and Molecular Action of Nutrients Ginger Extract Consumption Reduces Plasma Cholesterol, Inhibit. The Journal of Nutrition,130 (5), 1124-1131. https://doi.org/10.1093/jn/130.5.1124

[68] Ibrahim, S. S., Habiba, R. A., Shatta, A. A., & Embaby, H. E. (2002). Effect of soaking, germination, cooking and fermentation on antinutritional factors in cowpeas. *Molecular Nutrition & Food Research, 46*(2), 92–95. https://doi.org/10.1002/1521-3803(20020301)46:2<92::AID-FOOD92>3.0.CO;2-P

[69] Butt, M. S., Pasha, I., Sultan, M. T., Randhawa, M.A., Saeed, F., & Ahmed, W. (2013). Black Pepper and Health Claims: A Comprehensive Treatise. *Critical Reviews in Food Science and Nutrition, 53* (9), 875-886. https://doi.org/10.1080/10408398.2011.571799

[70] Abukawsar, M., Saleh-e-In, M., Ahsan, A., Rahim, M., Bhuiyan, N. H., Roy, S. K., Ghosh, A., & Naher, S. (2018). Chemical, pharmacological and nutritional quality assessment of black pepper (Piper nigrum L.) seed cultivars. *Journal of Food Biochemistry, 42* (6), 12590. https://doi.org/10.1111/jfbc.12590

[71] Jarosz, M., & Taraszewska, A. (2014). Risk factors for gastroesophageal reflux disease: the role of diet. *Gastroenterology Review, 9* (5), 297-301. https://doi.org/10.5114/pg.2014.46166

[72] Ocheme, O. B., Adedeji, O. E., Enyinnaya, C., Caleb, C., Yakubu, M., & Happiness, U. (2018). Proximate composition, functional, and pasting properties of wheat and groundnut protein concentrate flour blends. *Food Science & Nutrition, 6* (5), 1173-1178. 6–11. https://doi.org/10.1002/fsn3.670

[73] Sun, H., Wang, X., Wang, J., Shi, G., & Chen, L. (2019). Influence of the formula on the properties of a fast dispersible fruit tablet made from mango, Chlorella, and cactus powder. *Food Science & Nutrition, 8* (1), 479-488. https://doi.org/10.1002/fsn3.1330

[74] Lebaka, V. R., Wee, Y., & Ye, W. (2021). Nutritional Composition and Bioactive Compounds in Three Different Parts of Mango Fruit. *International Journal of Environmental Research & Public Health, 18* (2), 741. https://doi.org/10.3390/ijerph18020741

[75] Slavin, J. L., & Lloyd, B. (2012). Health benefits of fruits and vegetables. Advances in Nutrition, 3(4), 506-516. https://doi.org/10.3945/an.112.002154

[76] Astuti, R.M., Palupi, N. S., & Zakaria, F.R. (2016). Allergic reactivity of bambara groundnut (Vigna subterranea) proteins. *Food & Agricultural Immunology*, *27* (4), 535–546. https://doi.org/10.1080/09540105.2015.1129601

[77] Emanuel, S., & Hawarden, D. Peanut allergy. In: Yamamoto L, ed. Challenging cases in Peadiatric Emergency Medicine. American Academy of Pediatrics, 2016: 141-144.

[78] Oke, K. E., Adeyeye, S. A. O., & Olorode, O. O. (2022). Complementary Foods and Its Processing Methods: A Review. *Croatian Journal of Food Science and Technology*, *14* (1), 39-51. https://doi.org/10.17508/CJFST.2022.14.1.05

[79] WFP. (2019). Comprehensive Food Security and Vulnerability Analysis.https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/wfp_ethiopia_cfsva_report_june_2019.pdf

[80] Caroli, M., Mele, R. M., Tomaselli, M. A., Cammisa, M., Longo, F., & Attolini, E. (2012). Complementary feeding patterns in Europe with a special focus on Italy. *Nutrution Metabolism & Cardiovascular Diseases*, *22*(10), 813–818. https://doi.org/10.1016/j.numecd.2012.07.007

[81] Wright, C. M. (2004). Why are babies weaned early? Data from a prospective population based cohort study. *Archives of Disease in Childhood, 89* (9), 813-816. https://doi.org/10.1136/adc.2003.038448

[82] Brekke, H. K., Ludvigsson, J. F., Van Odijk, J., & Ludvigsson, J. (2005). Breastfeeding and introduction of solid foods in Swedish infants: The all babies in southeast Sweden study.

British Journal of Nutrition, 94 (3), 377-382. https://doi.org/10.1079/bjn20051499

[83] Giovannini, M., Riva, E., Banderali, G., Scaglioni, S., Veehof, S., Sala, M., Radaelli, G., & Agostoni, C. (2004). Feeding practices of infants through the first year of life in Italy. *Acta Paediatrica*, *93* (4), 492–497. https://doi.org/10.1080/08035250410025591

[84] WHO. Country Presentations. In: Dop, M. C., Benbouzid, D., Trèche, S., De Benoisf, B., Verster, A., & Delpeuch, F. Complementary feeding of young children in Africa and the Middle East. Geneva; 1999:217-254

Cite this article as: Dhliwayo, T. C., Nyanga, L. K., Chopera, P., Matsungo, T. M., Chidewe, C. (2022). A review of traditional grain-based complementary foods for children aged 6-23 months in selected African countries. *The North African Journal of Food and Nutrition Research, 6* (14): 115-125. https://doi.org/10.51745/najfnr.6.14.115-125