Moroccan Journal of Agricultural Sciences
Vol 4 No 4 (2023): (December 2023), 194-204
Nutrition and Food Technology

Research trends on the contribution of traditional food products to child nutrition in Africa's drylands

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Studies have described the diversity of traditional food resources and products (TFPs) in Africa. However, there is no study that maps the current scientific knowledge on the subject and establishes the most promising trends for their valorization in child nutrition. This review fills this gap and guides interventions to combat child malnutrition in Africa focused on local TFPs. A total of 596 scientific publications were exported from Scopus database, followed by bibliometric analysis using the biblioshiny web interface in R version 4.1.3. and by an interpretative analysis of clusters. The study revealed that the publications in our collection cover the period of 1971 to 2022 and were published in 269 journals and involved 2375 authors. Eight research clusters emerged from the mapping as trends. The most significant clusters highlighted that improving dietary diversity, providing sources of vitamin A, used as nutritious ingredients in the development of food products and incorporated into school feeding programs, are ways in which TFPs contribute to child nutrition. Knowledge gaps were identified and can be addressed through future research to fully leverage the opportunities offered by the diversity of traditional food products in Africa drylands to effectively combat child malnutrition.

Keywords: Traditional food products, Child malnutrition, Nutritional contribution, Research trends, Africa drylands

INTRODUCTION

The new global challenges of Covid-19 and climate change significantly impact livelihoods in Africa and increase vulnerability, particularly of the African drylands (Costello et al., 2009; Fanzo et al., 2018; Hagos et al., 2014; Nchanji and Lutomia, 2021). The Covid-19 and climate change effects mainly contribute to the persistence of child malnutrition which remains a major public health problem in many African countries (FAO, 2020), by limiting the production of nutritious and staple foods (Fanzo et al., 2018; Hagos et al., 2014; Jha et al., 2021; Mekonnen et al., 2022). In low- and middle-income countries, nearly 400 million children are affected by at least one micronutrient deficiency and over 200 million suffer from stunted growth or wasting (Unicef, 2020). The prevalence rates of stunting and wasting exceed 40% and reach around 15%, respectively in many arid countries (Akombi et al., 2017). Among the causes of this situation, the lack of continuous year-round supply of nutritious and affordable foods plays a significant role (De Carvalho et al., 2015; Wilson et al., 2021; Zotor et al. , 2015). It is necessary to consider more effective policies and

interventions that ensure a continuous supply of nutritious and affordable foods in African drylands to limit the progression of malnutrition. It is well-known that African arid regions are rich in a diversity of traditional food resources and products that have the potential to be nutritious, and many studies have explored their potential role in combating child malnutrition (Kansiime et al., 2018; Ochieng et al., 2018; Powell et al., 2011; Shumsky, 2011). This diversity could represent an opportunity to define new, more effective policies and interventions that promote and utilize traditional foods and food products to address child malnutrition (Mason et al., 2012). However, the current state of knowledge regarding trends and gaps in research on the valorization of traditional food products in children's nutrition is insufficiently understood. Therefore, this study aims at answering one fundamental research question: What is the state of research and trends on the contribution of traditional food products (TFPs) to improving the nutrition of children aged 6 to 59 months in African arid areas? To address this question, this study has analyzed the dynamics and trends of research on traditional food products in African drylands in relation to child nutrition, and has identified current knowledge gaps to guide future research.

METHODOLOGY

Study design

In order to address the research question, a bibliometric study was designed according to Aria and Cuccurullo (Aria and Cuccurullo, 2017), followed by a comprehensive interpretative literature review of the clusters (Palumbo et al., 2021). Bibliometric analysis involves the application of mathematical, statistical, and computational methods to quantify bibliographic data, enabling the assessment of research trends, impacts, and structures within a specific field (Ahmi, 2022). This approach allows for the analysis of a large volume of documents and examination of current knowledge trends within the field (Aria and Cuccurullo, 2017; José de Oliveira et al., 2019).

Data collection

Data collection for the bibliometric analysis was conducted by defining the Population, Intervention, and Outcome (PIO), variant of the Population, Intervention, Comparator and Outcome (PICO) literature search tool. This approach allowed us to establish the inclusion and exclusion criteria for the studies and formulate the corresponding research equation (Methley et al., 2014). In this study, the population of interest comprised studies focusing on traditional foods or food products, the intervention was their nutritional role or value and the outcome of interest was child nutrition. By combining these elements with synonymous terms, a comprehensive search equation, incorporating search operators such as '*', '?' was formulated to ensure a broad coverage of relevant documents. The titles, abstracts, and keywords of publications were searched in the Scopus database, which offers extensive coverage of scientific documents with references and citations across multiple disciplines (Martín-Martín et al. , 2018; Thelwall, 2018; Visser, van Eck and Waltman, 2021), using a research equation 1 as follow:

Equation 1: TITLE_ABS_KEY ((traditional AND food*) OR ({endogenous_food*}) OR ({indigenous_food*}) OR ({local_foodresource*}) OR ({african's_food*}) OR (local AND food*)) AND TITLE_ABS_KEY ((child* AND nutrition) OR (child* AND feeding) OR malnutrition OR (child? AND under AND five)) AND TITLE_ABSKEY (africa OR (drylands AND area*) OR (drylands AND zone*) OR dryland* OR ({Burkina? faso}) OR mali OR chad OR mauritania OR djibouti OR mozambique OR eritrea OR niger OR ethiopia OR senegal OR gambia OR somalia OR lesotho OR sudan OR malawi OR tanzania OR benin OR ({low-incomes countr ?}) OR ({developing countr ?}))).

In order to refine the search results and focus on the relevant literature, distant domains from the research topic were excluded based on the formulated equation 2.

Equation 2: (EXCLUDE (SUBJAREA,"BIOC") OR EXCLUDE (SUBJAREA,"ECON") OR EXCLUDE (SUBJAREA,"ARTS") OR EXCLUDE (SUBJAREA,"PHAR") OR EXCLUDE (SUBJAREA,"BUSI") OR EXCLUDE (SUBJAREA,"PSYC") OR EXCLUDE (SUBJAREA,"CENG") OR EXCLUDE (SUBJAREA,"ENER") OR EXCLUDE (SUBJAREA,"DENT ") OR EXCLUDE (SUBJAREA,"COMP") OR EXCLUDE (SUBJAREA,"PHYS") OR EXCLUDE (SUBJAREA,"VETE") OR EXCLUDE (SUBJAREA,"MATE")).

This exclusion helped to ensure that the retrieved studies were aligned with the specific subject of interest. By excluding unrelated domains, we aimed to enhance the precision and relevance of the search results, allowing for a more targeted analysis and interpretation of the findings.

The metadata exported per document are:

• Citation information (authors, years, source, title, volume, number, DOI, number of citations, etc.);

• Information (affiliation, series);

• Summary and keywords (author keywords and index keywords);

• Funding source and institution;

• References;

• Others.

Selection of articles for interpretative analysis

An interpretative analysis was conducted to synthesize the significant contributions from the most essential clusters relevant to our subject. Forty-six key articles from these clusters were selected for the interpretative synthesis based on the following criteria:

• Articles with the highest local citation counts within the cluster or acting as bridges within the cluster network.

• Original research articles (review articles were excluded).

• Examination of titles and abstracts addressing the concepts.

• Review of full-text articles providing relevant information on the concepts.

These selection criteria aimed to identify the most influential and informative articles within the identified clusters. By focusing on articles with high citation counts or those serving as bridges between clusters, we ensured the inclusion of influential research. Additionally, the examination of titles, abstracts and full-text articles allowed for a comprehensive understanding of the concepts and their relevance to the study.

Data analysis

In order to evaluate the trends, impacts and structures of research on the contribution of traditional food products to children's nutrition, the metadata extracted from scientific databases was visualized using R software (V4.1.3) through the biblioshiny interface (José de Oliveira et al., 2019). A descriptive quantitative analysis was conducted to comprehend the scope and impact of current research on the subject. This analysis examined publications by authors, journals, affiliated institutions and countries that were the focus of the research, as well as the evolution of annual

scientific production (Ahmi, 2022; Derviş, 2019).

To measure the impact of documents, authors or journals, their citation counts and H-Index were considered. The citation count reflects the number of times an author has been cited locally or globally within the collection (Ahmi, 2022). The H-Index is determined based on the set of most-cited articles from an author or source and the number of citations received (Aria and Cuccurullo, 2017).

The keywords associated with the topic were visualized through a word cloud comprising the top 50 keywords with the highest frequencies. A coupling (mapping) analysis was performed to understand the trends in the works. This analysis involved grouping documents based on references, local citation counts, and index keywords as parameters (Ahmi, 2022). The analysis considered the 250 most locally cited documents with a minimum frequency of grouped links of 10% with the references. Coupling occurs when two documents cite the same document, author, or source (Aria and Cuccurullo, 2017; Okaiyeto and Oguntibeju, 2021). This mapping analysis was complemented by an examination of the evolution of themes, providing insights into the historical changes and trends in research on the subject over time (Chen et al., 2019). These analyses were further enhanced by a synthesis of the contribution of traditional food products in the nutrition of children in African dryland zones through an interpretative analysis. The interpretative analysis aimed to identify significant scientific contributions from the most influential and related clusters to the research topic, as well as to identify research gaps for future exploration (Ahmi, 2022; Azad and Parvin, 2022).

RESULTS AND DISCUSSION

Overview of items included in the analysis

Five hundred and ninety-six documents were included in this analysis, of which 78% from original research articles, 11% from literature reviews and 11% from other types (e.g., books, book chapters, conference papers). These documents were published in 269 journals and involved 2375 authors, 24744 references, 1458 author keywords, and 3058 index keywords. There is a strong collaboration on the subject as indicated by a collaboration index of 4.62, with an average of 4.53 authors per document (Table 1). The earliest publication in the dataset dates back to 1971, while the most recent publication is from 2022. The analysis reveals a steadily increasing production of publications, surpassing 20 publications per year starting from 2013 (Figure 1). This demonstrates the interest and relevance of using traditional food products as a serious alternative in the fight against child malnutrition in Africa.

What are the most relevant sources in research on the contribution of TFPs to child nutrition in African drylands zones?

Among the 269 journals that have published documents on the subject, the journal «Food and Nutrition Bulletin» has the highest number of publications in our collection, with 26 articles. It is closely followed by the journal «Maternal and Child Nutrition» with 25 publications. The journals «African Journal of Food Agriculture Nutrition and Development» and «Acta Horticulturae» both have 17 publications, while «Food Security» has 15 publications, making up the top 5 (Figure 2). Assessing the impact of these journals using the H-index, we find that the journal «Food and Nutrition Bulletin» has the highest impact on the subject with an index of 12, followed by «Maternal and Child Nutrition» (H-index= 10), «Ecology of Food and Nutrition» (H-index= 9), and both «Food Security» and «Public Health Nutrition» (H-index = 8), completing the top 5 (Table 2). The publication of studies on the contribution of traditional food products to child nutrition in Africa is predominantly dominated by specialized journals that are not established in Africa. In the Top 10 of these journals, only one African journal appears. Additionally, no African journal appears in the Top 10 journals that have had the most impact on research in the field.

Who are the most important authors and institutions in research on the contribution of TFPs to child nutrition?

Out of the 2375 authors involved in research on the subject, the top 10 authors with the highest number of publications range from 4 to10 publications per author. These authors include Faber M, Afari-sefa V, Amuna P, Lindtjorn B, Linnemann AR, Oldewag-Theron W, Ashorn P, Baye K, Benades AJS, and Briend A (Figure 3). Faber M emerges as the author with the greatest impact in the field, with an H-index of 8. Following closely behind are Afari-sefa V (H-index = 5), and Amuna P, Ashorn P, Barnade AJS, and Briend A, each with an H-index of 4. However, the most cited authors in our collection (local citation) are Busse H, Fofanah M, Kurabachew H, and Ptak M, each with 8 citations (Figure 4). These authors are affiliated with various institutions, with the most prominent ones being the University of Kwazulu-Natal (33 publications), Stellenbosch University (31 publications), University College London (28 publications), and the World Vegetable Center (25 publications) in the top 5 (Figure 5). Research on the contribution of TFPs to nutrition in Africa is predominantly led by foreign institutions, with only three African institutions appearing in the top 10.

In which countries has research on the contribution of TFPs to child nutrition been conducted?

The research on the contribution of traditional food products to children's nutrition has covered several countries worldwide, with a particular focus on Africa (Figure 6).

The map illustrates that many African countries have been the subject of research on the topic. The most prominent countries in terms of published works are South Africa and Ethiopia, with over 100 publications each. Following closely are Tanzania, Kenya, and Senegal, with publications ranging between 50 and 100. Nigeria, Benin, Ghana, and Malawi have also recorded significant research with the number of publications ranging between 10 and 50. Research on the contribution of TFPs to child nutrition does not yet cover all African countries.

What are the most important publications and keywords in research on the contribution of TFPs to child nutrition?

Research on traditional food products leaded the publication of many works. The most cited document in our local collection is the one by Dibari et al. (2012) published in Journal of Nutrition with 8 citations. It is followed by the documents of Herrador et al. (2014) published in the journal Plus One and Phuka et al. (2011) published in the journal Maternal Child Nutrition, both with 5 citations each. The documents by Afari-Sefa et al. (2016) published in the journal Experimental Agriculture, Pillay et al. (2011) published in South african journal of Clinical Nutrition and Darmon et al. (2002) published in American journal of Clinical Nutrition completes the list of most cited documents with 4 citations each in the collection. The top 10 most cited documents are further complemented by the documents of Ochieng et al. (2018) published in the journal Renewable agriculture and food system, Workicho et al. (2016) published in BMC Public Health, Powell et al. (2011) in Int. forestry reviews and Faber and Wenhold (2007) in Water SA, each with 3 citations.

Publications on the contribution of traditional food products to children’s nutrition are associated with several keywords. The most important author keywords by frequency include malnutrition (52), «food security» (45), «Africa» (38), «nutrition» (37), «Ethiopia» (27), «dietary diversity» (23), «sub-Saharan Africa» (22), «children» (22), «breastfeeding» (19), and «South Africa» (19). The top 50 author keywords most frequently associated with the topic are presented in the word cloud in Figure 7.

What is the mapping of research on the contribution of TFPs to child nutrition in African drylands?

The scientific mapping resulting from the coupling clustering of the top 250 documents illustrates the most significant articles (impact, horizontal axis) and their connections (centrality, vertical axis) in research on the contribution of TFPs to child nutrition in arid African regions (Figure 8). Eight clusters emerge based on the centrality and impact of each cluster's sub-topic. Each cluster is represented by a unique color node, with node size reflecting the number of documents it comprises. The most essential and highly related clusters to our subject are located in the upper-right quadrant of the mapping. Clusters positioned in the lower-right quadrant are central but less closely linked to our research topic. Clusters found in the lower-left quadrant contain less essential articles that are also less connected to our subject, although they may include emerging terms relevant to our topic. Finally, clusters situated in the upper-left quadrant encompass articles related to our studied subject but are less essential, exhibiting a lower impact.

Clusters 6 (brown) and 2 (blue) emerge as the most essential and closely related to the contribution of TFPs to child nutrition in arid African regions. Cluster 6 has an impact of 1.85 and centrality of 0.42, consisting of 21 documents. The most significant articles in this cluster, with normalized local citations of 2.67, 2.67, and 1.75 respectively, include the works of Pillay et al. (2011), Faber and Wenhold (2007) and Faber et al. (2002). These articles focus on the contribution of TFPs as a source of vitamin A. Cluster 2 has an impact of 1.82 and centrality of 0.43, encompassing 60 documents. The most essential articles in this cluster, with normalized local citations of 5.22, 3.33, and 2.24 respectively, have been published by Dibari et al. (2012), Phuka et al. (2011) and Workicho et al. (2016). These articles explore the use of TFPs as ingredients and nutritional supplements in children's diets.

Clusters 1 (red) and 8 (ash) are central but less closely linked to the contribution of TFPs to child nutrition in arid African regions. Cluster 1, with an impact of 1.33 and centrality of 0.39, focuses on the contribution of TFPs to dietary diversity in children. It comprises 49 documents, with the most significant articles being those of Herrador et al. (2014), de Jager et al. (2017), and Herrador et al. (2015) with normalized local citations of 4.03, 1.94, and 1.81, respectively. Cluster 8 has an impact of 1.40 and centrality of 0.42, consisting of 16 documents that examine socio-cultural barriers and attitudes related to the consumption of TFPs in children's diets. The most essential articles in this cluster, with normalized local citations of 1.8, 1, and 0.98 respectively, have been published by Kodish et al. (2015), Pool et al. (2001) and Morales et al. (2021).

Clusters 3 (green) and 5 (orange) are less essential and closely linked to the contribution of TFPs to child nutrition in arid African regions. Cluster 3, with an impact of 1.14 and centrality of 0.37, comprises 42 documents. The most significant articles in this cluster, with normalized local citations of 1.96, 1.81 and 1 respectively, include the works of Schreinemachers et al. (2021), Bosu (2015)and Nel & Steyn (2022).These articles explore current transitions observed in the use of TFPs. Cluster 5 has an impact of 1.47 and centrality of 0.36, encompassing 28 documents that examine the socio-cultural aspects of TFPs. The most essential articles in this cluster, with normalized local citations of 1.94, 1.94 and 1, respectively, are the works of Chakona (2020), Chakona and Shackleton (2018) and Gebretsadik et al. (2022).

Clusters 4 (purple) and 7 (pink) consist of articles related to the contribution of TFPs to child nutrition in arid African regions but are less essential. Cluster 4 contains 26 documents with an impact of 1.52 and centrality of 0.39, focusing on African leafy vegetables and fermented foods used in children's diets. The most essential articles in this cluster, with normalized local citations of 3.23, 2.84, and 1.61 respectively, have been published by Afari-Sefa et al. (2016), Ochieng et al. (2018) and Franz et al. (2014). Cluster 7 consists of 8 articles with an impact of 1.74 and centrality of 0.35, examining wild TFPs and forests. The most essential articles in this cluster, with normalized local citations of 2.0, 1.86, and 1.79 respectively, are the works of Powell et al. (2011), Haidar and Kogi-Makau (2009) and Powell et al. (2013).

The mapping shows that around 80 scientific publications are the most essential and important ones illustrating the contribution of traditional food products to child nutrition in arid African areas.

These documents essentially explain the use of traditional food products as a source of vitamins and minerals and as ingredients and nutritional supplements in children's diets. Although other trends are not negligible, these two trends remain the most dominant in current interventions against malnutrition based on the use of local foods and food sources.

Contribution of traditional food products to the fight against child malnutrition in African drylands zones

The research on the contribution of Traditional Food Products (TFPs) to child nutrition has highlighted the diverse range of locally known food resources of animal and plant origin in Africa. These TFPs are utilized in various forms and socio-cultural contexts (Mabhaudhi et al., 2018; Pichop et al., 2016; Tirivangasi, 2021). They can be cultivated or found in the wild, including forests and play a crucial role in combating child malnutrition in arid regions of Africa (Ebert, 2020; Ghosh-Jerath et al., 2021; Powell et al., 2013). One significant category of TFPs is traditional leafy vegetables which are sources of micronutrients and contribute to the nutritional well-being of children. Various studies have identified African eggplant, amaranth, Ethiopian mustard, African nightshade, sweet potato leaves, okra and pumpkin leaves as commonly consumed vegetables in the diet of children in Tanzania (Afari-Sefa et al., 2016; Misci et al., 2022; Ochieng et al., 2018). Additionally, traditional fruit and vegetable gardens including sweet orange and carrot, along with fortified staples like maize, have been shown to improve vitamin A intake in children under five (Amoussa-Hounkpatin et al., 2012; Busse et al., 2017; Chawafambira et al., 2021; De Moura et al., 2014; Faber et al., 2002; Roos et al., 2007). Fermented foods made from maize, sorghum, millet, animal proteins, and tubers also contribute to optimal child nutrition by providing additional energy, vitamins and bioavailable micronutrients (Franz et al., 2014). Furthermore, TFPs have proven to be excellent ingredients for the development of nutritious foods and supplements for children. These traditional food products have served as the foundation for the creation of a wide range of nutritious food options specifically designed for children aged 6-59 months in arid regions of Africa (Table 3).

The TFPs are also promoted as nutritious ingredients in school feeding programs across dryland countries in Africa (Garine, 2010; Gora, 2018). Leafy vegetables and certain local fish have been recognized as valuable sources of essential micronutrients, vitamins and proteins in numerous school feeding programs in sub-Saharan Africa (Ahern et al., 2021; Wineman et al., 2022). Furthermore, edible insects have been identified as protein sources that can contribute to improving children's diets, as highlighted by Tao and Li (2018) and Hongbété and Kindossi (2017). Thirdly, TFPs play a crucial role in enhancing children's dietary diversity. Studies conducted by Herrador et al. (2015) and Potts et al. (2019) showed that the consumption of animal-based foods such as milk, meat and eggs improves the dietary diversity score of school-aged children and enhances their intake of zinc, iron, and proteins. Additionally, the use of powdered supplements derived from nutritious local foods enables pregnant women to achieve a diverse food intake, aligning with the Malawi Dietary Guidelines' recommendation of consuming foods from the six food groups (Katenga-Kaunda et al., 2022).

Research gaps and future research

To summarize, research on the contribution of TFPs to fight against child malnutrition in African dryland areas reveals some important findings. Despite these findings, several scientific questions remain unanswered and addressing them is crucial to fully harness the nutritional potential of TFPs: why has the diversity and potential of TFPs not translated into sustained access to nutritious food in African drylands? What are the barriers preventing the scaling up of nutritious foods developed from TFPs to effectively fight against child malnutrition in these regions?

Exploring the methods for developing nutritious foods from TFPs is essential in finding answers to these questions and guiding future research directions. Additionally, the nutritional values of traditional food preparations which hold cultural connotations and values (Garine, 2010; Gora,

2018) are currently under-documented. Knowledge of the nutritional composition of these traditional foods and preparations can serve as a foundation for the development of new and improved nutritious foods. Enhancing the understanding and documentation of these values may promote greater adoption of nutritious foods derived from TFPs. Given the limitations of current interventions, addressing these existing knowledge gaps represents a promising avenue for improving the utilization of locally developed, affordable and year-round available nutritious foods (Frank et al., 2022; Hammond and Dubé, 2012).

CONCLUSION

The analysis of the scope, impact and trends of research on the contribution of traditional food products (TFPs) to the fight against child malnutrition in African dryland areas reveals several important findings. Firstly, many studies have been conducted by authors affiliated with institutions in various countries indicating a widespread interest in the topic. Secondly, these studies have identified diverse uses of TFPs to improve child nutrition including the development of nutritious complementary foods and their integration into school feeding programs. The research on the contribution of traditional food products (TFPs) to child nutrition in African drylands has evolved over time. It initially focused on concepts like nutrition and rehabilitation, while recent trends include food security, complementary feeding, and nutritional fortification. TFPs, such as leafy vegetables and fruits have been recognized for their micronutrient content and are utilized in child diets. They have also been used in school feeding programs and as ingredient in nutritious food development, contributing to dietary diversity and improving nutritional intake. Despite progress, challenges remain in scaling up the use of TFPs to combat child malnutrition in African drylands, warranting further research and documentation of their nutritional value.

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