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The Importance of Food Plant Nutrients in the Management of Severe Respiratory Infections Focusing on Their Immunomodulatory, Anti-inflammatory and Antioxidant Properties

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Abstract Respiratory tract infections are currently a public health emergency of international concern. In addition to the worldwide public-health vaccination campaigns and treatments, emphasis could be placed on promoting the consumption of food plants rich in immunomodulatory, anti-inflammatory and antioxidant micronutrients as a sustainable solution. The potential of local foods in Africa is not well known for this purpose. In this review, the aim is to correlate the evidence from previous and recent studies on the effects of food plants on immunity and respiratory tract infections to the evaluation of the potential benefits of the consumption of African indigenous and traditional plants based foods in the newly emerging respiratory infectious agent's context. A number of studies have shown that vitamins (A, C, E, B2, B6 and B9) and mineral (zinc and iron) may have the potential to benefit both healthy people and patients against respiratory infections including COVID-19 due to their immunomodulatory, anti-inflammatory and antioxidant properties. Several African plants based food have the potential to provide these essential non-synthetic micronutrients to preserve organism defense mechanisms against infectious agents or to manage clinical symptoms of respiratory diseases.

Keywords: *COVID-19, food plants, functional foods, respiratory infections, viral diseases, Africa*

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1. Introduction

Respiratory tract infections are among the most common causes of death and disability in the world. Globally, 4 million people die prematurely from chronic respiratory diseases [1]. It is estimated that lower respiratory tract infection causes nearly 4 million deaths annually and is a leading cause of death among children under 5 years old [2]. The global incident cases of upper respiratory infections reached 17.2 billion in 2019 accounting for 42.82% cases from all the diseases and injuries in the Global Burden of Diseases 2019 study [3]. Sub-Saharan Africa is, with South Asia, among the world mostly affected region by respiratory tract infections [1]. More than two-thirds of acute lower respiratory infections cases occur in these two regions of the world [4].

The clinical spectrum of respiratory infections appears wide, encompassing coughing, a sore throat, nasal obstruction, headache, and severe complications with otitis media, glomerulonephritis, myocarditis and respiratory failure [5,6]. This clinical spectrum may also significantly impair life quality and productivity [5,7,8].

Respiratory infections are mainly caused by viruses, including rhinovirus, coronavirus, respiratory syncytial virus and so on [9,10]. After virus infections, bacterial colonization may occur in some cases, which aggravates the disease and leads to prolonged recovery [10,11]. The recent respiratory infection pandemic, called the novel 2019 coronavirus disease (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) further exposed the potential threats of respiratory viruses [12]. During the last few years, the COVID-19 has spread around the world [13-16]. The wide clinical spectrum of this newly emerging viral disease includes asymptomatic infection, mild upper respiratory tract infection, and severe pneumonia with respiratory failure [15,17,18].

Lower and upper respiratory infections can be prevented or reduced by several measures. For example, improving nutrition; improving living conditions to prevent crowding; treating or giving prophylactic drugs can be appropriate for respiratory infections treatment or prevention in adults and childhood [1].

A number of reviews have dwelt upon the role of nutrition in the management of lower and upper respiratory symptoms. It is well established that food components are key elements in strengthening the immune system and remain closely associated with host resistance against any infectious agent including respiratory infectious viruses and bacterial colonization [19-23]. The role of food components in strengthening the immune system and protecting against any respiratory infections has been attributed to their immunomodulatory, anti-inflammatory and antioxidant properties [19-23].

Unanimously, a healthy immune system has been recognized as the mainstay for tackling any respiratory infections. The prompt management of nutritional disorders may reduce severe complications of respiratory infections with respiratory failure and mortality [20,21,23,24]. Many plants based nutrients are known to have several health benefits including immunomodulatory, anti-inflammatory and antioxidant properties [25]. These food components include vitamins A, B, C, E, and trace elements such as zinc and iron [26].

The objective of this review is to correlate the evidence from studies on the effects of food plant nutrients on immunity, viral respiratory tract infections to the evaluation of the potential benefits of the consumption of African indigenous and traditional plants based foods in the newly emerging respiratory infections context.

2. Methods

2.1. Literature Search

During January 2020 and March 2021, literature searches were conducted by means of Web of Science, Pubmed and Google Scholar, using the key words and/or phrases “African food plant composition”, “Food plant nutrients”, “Proximate composition of leafy vegetables”, “African fruits”, “Functional nutrients”, “Micronutrients”, “COVID-19”, “COVID-19 and supportive therapies”, “Respiratory tract infections” and “Viral diseases”, “Lower and upper respiratory infections”. Reference lists of scientific articles were cross-checked and only relevant papers published up to 30th March 2021 were included.

2.2. Inclusion and Exclusion Criteria

This study focused on the importance of African food plant nutritional value in the management of respiratory infections. The studies on the nutritional value of indigenous, traditional and exotics vegetables in Africa were included. International Network of Food Data Systems [27] and food composition tables for use in Africa were included. Title, abstract and then full text of all articles were screened for eligibility. Only food plant nutritional value was considered. Other food matrices were excluded.

2.3. Study Categorization

The included studies were categorized into three sections: i) data on the clinical and physiopathological characteristics of lower and upper respiratory infections, ii) data on the benefits associated with food nutrients intakes in infections including viral, respiratory tract infections, and iii) data on the African food plant nutritional value which may have the potential to benefit healthy and infected people. All of these three data sections were combined to write the final manuscript.

2.4. Data Extraction

The data from food composition tables and journals were extracted using a predefined data extraction table. The content of the data extraction table included the name (English, French and scientific name) and nutrient content (vitamins and minerals) of food plants, and references of data sources. The importance of each food plant nutritional value has been analysed according to the beneficial effect in the protection of the population health, particularly the management of respiratory infections.

3. Results and Discussion

3.1. Vitamin A

Vitamin A is known as "the anti-infective” due to its regulatory function in both cellular and humoral immune response [26,28,29]. This micronutrient helps in regulating the production of IL such as IL-2 and the pro-inflammatory tumor necrosis factor-α (TNF-α), which activates the microbial action of macrophages [30]. The use of vitamin A as a supplement has shown a positive impact in reducing the severity of pneumonia and enhancing immunity in viral infections including the *influenza virus* [31-34].

Plant based foods are considered to be rich in provitamin A when the content is superior to 0.3 mg (300 µg) RE for 100g of consumed food [35]. Based on this definition, the main food sources of provitamin A in Africa, presented in Table 1, are leafy vegetables, fruits, nuts products and root vegetables. Among leafy vegetables the important sources of provitamin A are found in spinach (*Spinacia oleracea*) with 669 µg RE/100 g, Black jack (*Bidens pilosa*) with 985 µg RE/100 g, Cassava (*Manihot esculenta*) with 1970 µg RE/100 g, spider plant (*Cleome* sp.) with 1200 µg RE/100 g and Moringa leaves (*Moringa oleifera)* with 18900 µg RE/100 g. Regarding fruits, the best provider of provitamin A are mandarin, tangerine and clementine with 334 µg RE/100g, néré, the fruit of the African locust tree (*Parkia biglobosa*) with up to 2430 µg RE/100 g, mangoes (*Mangifera indica*) with 330 µg RE/100g, sweet detar (*Detarium microcarpum*) with 312 µg RE/100 g, and weda, the fruit of *Saba senegalensis* with 1559 µg RE/100 g. Among nuts products, red palm oil extracted from the pulp of the palm tree nuts (*Elaeis guineensis*) with 11 400-300000 µg RE/100 g, is the most important provitamin A food source. The provitamin A content in root vegetables, such as carrots (*Daucus carota*) and sweet potatoes (*Ipomoea batatas*) varies from 109 to 16000 µg RE/100 g. The Recommended Daily Allowance (RDA) of vitamin A ranges globally between 375 mg RE/day and 850 mg RE/day while requirements for preschool-age children ranges from 200–400 mg RE daily [36].

Table 1. Main functional food constituents and their sources specific to Africa compiled from articles and different food tables (food composition tables for use in Africa)

English name	French name	Scientific name (Vernacular names)	Vitamins (mg/100 g)						Minerals		References
			Vitamin A*	Vitamin C	Vitamin E	Vitamin B2	Vitamin B6	Vitamin B9	Iron	Zinc	
Leafy Vegetables											
African baobab, fresh leaves (raw)	Baobab, feuilles fraîches	*Adansonia digitata* (Toega)	197-426.	47	0.4-1.4	0.04	0.3-0.4	97-118	3.90	0.9	[71,72]
Amaranth, fresh leaves (raw)	Amarante, feuilles fraîches	*Amaranthus cruentus* (Brombrou)	241	45-369.	0.2	0.3-2.7	0.2	648.0	5.2-40.5	0.7	[72,73]
Black jack, fresh leaves (raw)	Bident poilu, Sornet ou Herbe à aiguilles	*Bidens pilosa*	301.0-985.0	23.0	0.2	-	-	351.0	2.-6.	0.9-2.6	[74]
Cassava, fresh leaves (raw)	Manioc, feuilles fraîches	*Manihot esculenta* (Fingninman)	286-1970	39-311	2.4	0.5-0.6	0,3	118	5.5	0.7	[72,74]
Cowpea, fresh leaves (raw)	Niebé, feuilles fraîches	*Vigna unguiculata* (Bengedo)	99-537	9-57	2.36	0.1-0.4	0.2	105-141	4.7-5.1	0.2-0.5	[72,74,75]
Mint, fresh leaves. (raw)	Menthe, feuilles fraîches	*Mentha longifolia*	767	31.7	0.5	0.2	0.2	100	8.6-80.3	0.7-8.2	[71,76]
Moringa, fresh leaves, (raw)	Moringa, feuilles fraîches	*Moringa oleifera*	18900	19.3		20.5			17.5-126.2	1.3-3.3	[77,78]
Pumpkin, fresh leaves (raw)	Citrouille. Feuilles fraîches.	*Cucurbita pepo subsp. pepo* (Elegede)	325	2	-	0.1	-	47	9.2	0.7	[75]
Spider plant, fresh leaves, (raw)	Plante-araignée. feuilles fraîches.	*Cleome sp.*	434-1200	13-64	0.1-2.2	0.2-0.9	0.3	121-350	2.1-6.9	0.6-1	[71,74,75]
Spinach, fresh leaves (raw)	Épinard. feuilles fraîches.	*Spinacia oleraceaa*	409-669	36-28	2.3	0.2-0.2	0.2	176-194	2.7-3.1	0.5-0.8	[71,74,79]
Tamarind, fresh leaves. (raw)	Tamarin,	*Tamarindus indica* (Ukwaju)	28	6	0.8	0.1	0.1	120	2.8	1	[71]
Fruits											
African baobab, fruit pulp	Baobab, pulpe du fruit	*Adansonia digitata* (Toega)	70-112	209-575	-	0.1	0.02	-	1.1-15	0.5-3.2	[72,80-84]
African locust bean, fruit pulp (Néré)	Néré. pulpe du fruit	*Parkia biglobosa* (Néré, Dorowa)	203-2430	164-234	-	0.7	-	-	8-181.4	1.2-43.7	[81,84-87]
African desert date	Jujube, pulpe du fruit	*Balanites aegyptiaca*	22	6.8-62.8	0.03	0.03	0.1	-	4.9-24.4	0.6-2.9	[72,84,88-90]
Black plum, West African plum	Prunier noir, koro	*Vitex doniana* (Mfudu, mfuru)	11-270	35.6-48.9	0.03-6.2	4.8	8.7-20.4	-	5.2	-	[91,92]
Gardenia fruit	Gardenia femelle	*Gardenia erubescens (Subduga, Glé)*	-	186.3	-	-	-	-	47.3	27.8	[85]
Guava, pulp	Goyave, Goyavier, Gouyave, pulpe du fruit	*Psidium guajava* (Guwâfah)	44	243-268	0.1	0.04	0.1	7-10	0.8	0.2	[71,93]
Jujube, Pulp	Jujube, pulpe du fruit	*Ziziphus mauritiana* (Beri)	11	55-2405	0.02	0.1	0.1	6	0.9-1.2	0.03 - 0.05	[71,88,93]
Karité, fruit pulp	Karité, pulpe du fruit	*Vitellaria paradoxa*	-	-	-	-	-	-	0.01-180	0.5-10.1	[84,86,87,94]
Mandarin, Tangerine and Clementine; pulp	Mandarine,Tangérine, Clémentine, pulpe du fruit	*Citrus retieulata*	250-334	29-41	0.5	0.04	0.04	26.0	-	0.1	[71,93]
Monkey cola, fruit, mesocarp		*Cola millenii* (Obi edun, Atewo-edun)	-	953.3	-	-	-	-	197.2	56	[85]
Mangoes , fresh pulp	Mangue, pulpe fraiche du fruit	*Mangifera indica*	330	5-44	1.8	0.05	0.1	51	9.3	9.3	[93,95,96,97]
Orange, sweet; juice, fresh	Orange, jus	*Citrus sinensis (L.) Osb*	741	384	0.2	0.03-0.3	0.05	37-273	0.4-1.3	0.04 -0.8	[25,93]
Sweet detar, dattock,, pulp	Dankh, petit détar, pulpe du fruit	*Detarium microcarpum*	312	2.4-4.6	-	-	-	-	-	-	[88]
Tamarind, pulp (rip)	Tamarin, tamarinier, pulpe du fruit	*Tamarindus indica* (Ukwaju, Dhakar)	8.0	10	0.1	0.2	0.1	9	3.1	0.5	[71]
Weda, fruit pulp	Liane saba, Weda, pulpe du fruit	*Saba senegalensis* (Maad , Saba, weda)	1559	34.8-480	0.1	-	-	-	-	-	[88,98]

English name	French name	Scientific name (Vernacular names)	Vitamins (mg/100 g)						Minerals		References
			Vitamin A*	Vitamin C	Vitamin E	Vitamin B2	Vitamin B6	Vitamin B9	Iron	Zinc	
Nuts,/seeds											
African locust bean, fermented seeds	Néré, grains fermentés	*Parkia biglobosa* (Soumbala, afitin)	8.36	6.0	0.4	-	-	-	12.2-35	5.4-14	[81,84,86,87, 94,99]
Benniseed, Sesame seed, dried raw	Grains de sésame séché crue	*Sesamum indicum*	2-3	6	0.2-1.3	0.04-0-2	0.1-0.	8-97	11.8-42.3	2.7-7.7	[71,72]
Cashew nut, raw	Noix de cajou, Noix d'acajou	*Anacardium occidentale*	3	134-135	0.8-2.1	2.9-3.9	0.4	-	5.3-6.4	4.6-5.4	[72,100,101]
Cashew apple	Pomme de cajou, Pomme d'acajou	*Anacardium occidentale*	-	200-300	-	-	-	-	0.4-3.0	-	[102,103]
French nut, seed		*Bombax glabra*	-	69.92	-	-	-	-	39	30.3	[85]
Jackfruit, seed	Jaquier, grains	*Artocarpus heterophyllus*	-	151.8	-	-	-	-	19.8	20.1	[85]
Monkey cola, seed		*Cola millenii*	-	144.3	-	-	-	-	48;1	31.9	[85]
Monkey orange, wild orange, seed		*Strychnos innocua*	-	31	-	-	-	-	44.1	31.8	[85]
Red palm oil, crude	Huile de palme rouge	*Elaeis guineensis*	11 400-300000	-	15	0.02	-	-	0.2	-	[71,104,105]
Root vegetables											
Carrots	Carottes	*Daucus carota*	102.2-500	8	-	1	15.4	-	0.7-1.3	0.3	[106]
Ginger, root. raw	Gingembre, racine crue	*Zingiber officinale*	15	5	0.3	0.04	0.2	11	1.9	0.4	[71]
Orange-fleshed sweet potato	Patate douce à chair orange	*Ipomoea batatas*	1580-16000	5-31	1	0.05-0.3	0.1-0.2	11-80	0.9-3.6	0.2-0.6	[71,72,107]

The symbol "-" indicates that there were no data available
*The levels of vitamin A in plant foods are given in µg RE/100 g.

3.2. B Vitamins

Most of B-complex vitamins act as coenzymes and precursors in many cellular functions and therefore are involved in a broad spectrum of cellular metabolic reactions [26,37]. Among B-complex vitamins, vitamins B2, B6, and B9 (folate) are particularly important in cell-mediated immunity functions [26]. It is known that vitamin B6 acts as a coenzyme in the metabolism of antibodies, and its deficiency is associated with decreased antibody response [38]. Even marginal, vitamin B6 deficiency could impair the maturation and growth of lymphocytes [38,39]. Vitamin B6 deficiency is also associated with decreased numbers and function of T lymphocytes which can be reversed with short-term consumption of vitamin B6 [38,39]. Individuals with normal vitamins B2, B6 and B9 status have a decreased risk of respiratory tract infections with enhanced cellular immunity compared to those with poor B-complex vitamin status [40]. B-complex vitamin deficiencies, specially vitamin B9 are prevalent in Africa due to food processing and the predominantly cereal-based diet [41]. Children and their mothers are the most vulnerable group [41].

Vitamins B2, B6 and B9 are omnipresent in African plant based food as presented in Table 1. Vitamin B2 levels of some leafy vegetables such as Amaranth (*Amaranthus cruentus*) with content up to 2.7 mg/100 g and Moringa (*Moringa oleifera*), with content up to 20.5 mg/100 g, are higher than the Recommended Nutrient Intake (RNI) for most of the population [36]. Indeed, 0.3-1 mg of vitamin B2 per day is enough to cover the needs of infants and young children while 1.3 mg of vitamin B2 per day would satisfy the vitamin B2 requirements of women and men [36].

Vitamin B6 content varies from 0.02 to 20.4 mg/100 g, depending on food plants (Table 1). The richest vitamin B6 food products include carrots (*Daucus carota*), with a content of 15.4 mg/100 g, and Black plum (*Vitex doniana*), a fruit, containing 8.7-20.4 mg/100 g. Vitamin B6 requirements are 0.1-1 mg/day for infants and children, 1.2 mg/day for women and 1.3 mg/day for men [36].

Rich sources of vitamin B9 are leafy vegetables (Table 1). Among leafy vegetables, the order of vitamin B9 content could be defined as follow: Amaranth (648 mg/100 g) > Black jack (351 mg/100 g) > Spider plant (121-350 mg/100g) > Spinach (176-194 mg/100g) > Cowpea (105-141 mg/100g) > African baobab (97-118 mg/100 g) > Cassava (118 mg/100g) > Tamarind (120 mg/100g) > Mint (100 mg/100g) (Table 1). Vitamin B9 requirements of most of the population including adolescents, adults and the elderly are 400 µg per day [36].

3.3. Vitamin C

The few available data that mentioned supportive nutrition during respiratory infections including COVID-19 treatments suggests that vitamin C could be a crucial micronutrient in strengthening immune functions and protecting against health disorders caused by infectious viruses and other agents [21,22]. This food component has been reported to reduce incidence of various respiratory tract infections [37,42-45]. The frequent ingestion of vitamin C can decrease the risk of developing more serious respiratory infections and prevent viral infections by enhancing various immune cell functions including T-lymphocyte proliferation [38,46-49]. This nutrient is one of food components that is readily mobilized during infection and its concentration increases in leukocytes (neutrophils and monocytes) [38].

To evaluate vitamin C benefits as an effective COVID-19 adjuvant therapy, an ongoing clinical trial for COVID-19 treatment (NCT04264533) is currently conducted in China with 12g of vitamin C injected intravenously (IV) twice daily [50].

As provided in Table 1, major sources of naturally occurring vitamin C are mainly fruits and to a lesser extent nuts products. Fruits could be classified in three groups with different vitamin C contents: (i) fruits exhibiting the highest vitamin C content (> 500 mg/100 g) are African baobab (up to 575 mg/100 g), Monkey cola (up to 953.3 mg/100 g), Jujube (up to 2405 mg/100 g), (ii) fruits exhibiting vitamin C content that ranges from 200 to 500 mg/100 g are néré (up to 234 mg/100 g), guava (243-268 mg/100 g), orange (384 mg/100 g) and weda (up to 480 mg/100 g); (iii) fruits with vitamin C content within the range under 200 mg/100 g such as gardenia fruits (*Gardenia erubescens*). In general, the RDA of vitamin C ranges from 40 to 110 mg/day [51]. However, prophylaxis of infection requires dietary vitamin C intakes of 100-200 mg/day [47]. The treatment of established infections requires around 6 g/day to compensate the high metabolic demand due to the increased inflammatory response [47].

3.4. Vitamin E

Vitamin E deficiency is well recognized to impair both humoral and cellular immunity [52]. However, the potential of this food component to benefit patients with viral respiratory tract diseases is somewhat controversial. Indeed, vitamin E could improve T-cell-mediated immunity and increase the production of antibodies in response to viral diseases in general [53]. However the effectiveness of the use of vitamin E supplements on respiratory tract infection has not been concluded from the few available studies on the subject [54]. Nevertheless, regarding the established role of vitamin E in strengthening immune function against viral infections [55,56,57], benefits of a rich-diet in vitamin E may be conferred to healthy subjects, specially elderly in newly emerging viral diseases prevention.

Vitamin E content in food products presented in Table 1 ranges from 0.03 to 15 mg /100g of edible potion. Palm oil is the best source of this micronutrient (15 mg /100g). The use of the latter could serve as a strategy for strengthening immunity against newly emerging viral diseases and to a larger extent to tackle micronutrient deficiency. The RDA ranges globally between 7 and 15 mg [26].

3.5. Zinc

Zinc deficiency induces thymic atrophy, decreases lymphocyte number and activity, and increases inflammation by altering cytokine production [54,58]. This deficiency could increase the risk of all types of infection including viral respiratory tract infections [59,60]. It has been reported that the ingestion of zinc (150 mg/day) in elderly was effective in enhancing thymic function and the output of new CD4+ naïve T cells, helping to prevent the reactivation of torquetenovirus [61]. Other studies have also shown that zinc could be an effective adjuvant therapy for treating respiratory tract infections in general, and the common cold specially [59,62,63].

The main sources of zinc, which are shown in Table 1, include three fruits (néré, containing up to 43.7 mg/100 g, Gardenia, containing 27.8 mg/100 g, Monkey cola (*Cola millenii*), containing 56 mg/100 g) and four nuts/seeds (*Artocarpus heterophyllus*, containing 20.1 mg/100 g, *Bombax glabra*, *Cola millenii*, *Strychnos innocua*, containing more than 30 mg/100 g).

3.6. Iron

This micronutrient may have the potential to benefit heathy subjects and infected patients due to the drawbacks of iron deficiency on weakening immunity in infections, especially in viral acute respiratory tract infections [19,64,65]. Studies, performed on both young children and adults observed that iron deficiency was associated with the weakening of cellular immunity and a decrease in the number of circulating T lymphocytes [66]. A case-control study in hospitalized children, at the paediatric ward, in Sri Lanka, has stated that iron deficiency was a risk factor for the development of recurrent acute respiratory tract infections and following a period of 3- months of oral iron supplementation (60-120 mg daily) by children with haemoglobin 9-10 g/dL, recurrent acute respiratory tract infections were reduced to 90% [65]. Iron deficiency is well-known to be a major type of anaemia. Anaemic patients are more prone to develop recurrent acute respiratory tract infections [65]. Anaemia is a major public health issue in Africa, affecting 67.6 % of preschool-age children and 57.1 % of pregnant women [67].

Rich sources of iron could be found among all type of food products presented in Table 1. Some of them exhibit high iron content up to 255.6 mg/100 g (*Gnetum africanum*). Leafy vegetables such as Mint (*Mentha longifolia*) could contain up to 80.3 mg/100 g of iron. Among fruits, Monkey cola (*Cola millenii*), Néré (*Parkia biglobosa*), Karité (*Vitellaria paradoxa*), Gardenia (*Gardenia erubescens*), are the most important sources of iron. Among nuts and seeds, *Cola millenii*, Benniseed (*Sesamum indicum*), *Strychnos innocua*, *Bombax glabra*, are the most important sources of iron, containing up to 48.1 mg/100 g, 45 mg/100 g, 44.1 mg/100 g, 39 mg/100 g, respectively. Soumbala, the fermented seeds of néré and seeds *of Artocarpus heterophyllus* are the most important seeds sources of iron, containing up to 35 mg/100 g and 19.8 mg/100 g, respectively. The RNI for infants and children, for men and women is 6-18.6 mg/day and 9-30 mg/day, respectively [36].

3.7. Study Limits

The bioavailability or bioaccessibility, the chemistry and stability of food plant nutrients, food processing, and food matrix effects on nutrient have not been investigated in this review even though these aspects can adversely impact on the beneficial effect of nutrients. For example, in native food plants, B vitamins are known to be in different forms. These forms may have different bioavailability or bioaccessibility due to food matrix effects or the presence of some inhibitors of B vitamin digestive enzymes in humans [68,69]. A study by Ringling and Richlik (2017) [69], investigating the influence of the food matrix on the deconjugation and stability of food folates during digestion, revealed that the presence or the absence of some organic acids such as ascorbic acids can affect the stability and probably the bioavailability of food folates too. Besides, most sources of these micronutrients (Vitamins A, B, C, E Zinc and Iron) are still processed before consumption and food processing steps can significantly impact nutrient content as mentioned in previous studies [41]. A recent study carried out in West African countries by Saubade et al. (2018) [70] showed that some food processing steps such as debranning, soaking and wet-milling decreased the folate content of some food plant products. Nevertheless, the findings are relevant in the current state of severe respiratory infections. For example, in the COVID-19 context, while treatments and vaccines are being developed, new variants of this acute respiratory distress syndrome were more and more identified around the world compromising the current vaccine protection. Until widely available, efficient treatments or vaccines exist, strengthening the immune system and protecting against respiratory infections are the best hope to mitigate this pandemic across the globe. The review highlights the potential of African food plant micronutrients which may be beneficial to both healthy and infected people.

4. Conclusion

In the African context of widespread nutritional disorders and respiratory infections including the acute respiratory distress syndrome causing by SARS-CoV-2, nutritional strategies for enhancing immunity based on the potential of local foods for the poorest are to be explored. This review highlighted the potential of African food plant constituents which may be beneficial to both healthy and infected people. Findings of this review should encourage further research in nutraceuticals development to improve immune responses against newly emerging viral diseases of respiratory tract including COVID-19.

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F. Bationo conceived and designed the research; F. Bationo, M. Goubgou and D. Compaoré-Sérémé: conducted research and wrote paper.

Conflicts of Interest

The authors declare no conflict of interest.

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