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# Mushrooms as a strategy to reduce food insecurity in Colombia

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## Abstract

**Purpose** – This paper aims to address the issue of food security and its role in the inclusion of edible and medicinal mushrooms in the diets of nutritionally vulnerable populations in Colombia, allowing an overview of the nutritional situation and its main structural causes, the importance of food security programs, the advantages and disadvantages of the use of mushrooms and strategies and challenges in promoting the cultivation and consumption of macromycetes.

**Design/methodology/approach** – An extensive literature review was conducted to develop this viewpoint paper.

**Findings** – According to the results of this study, for edible fungi to become a viable alternative in the Colombian food culture, it is necessary to develop strategies and educational programs for food security, to conduct applied research to assess the incorporation of mushrooms into the food culture of the communities and to consider the acceptability of this food. This requires promoting the properties of mushrooms and considering their nutritional and/or medicinal contributions, self-consumption, commercialization to buy other food and the utilization of by-products or agricultural residues for cultivation, all while paying heed to the implications of food safety and regulations. The contributions of different professionals in social and technical areas in transferring knowledge to the community, and especially to “replicator leaders”, is also of great relevance to the acceptability of these ideas within communities.

**Social implications** – Edible fungi are a possible response to malnutrition problems in adult and infant populations in Colombia.

**Originality/value** – No previous study has investigated the potential of mushrooms as a strategy to decrease food insecurity in Colombia.

**Keywords** Malnutrition, Food security, Fungi, Agricultural waste, Macromycetes

**Paper type** Viewpoint

## Nutritional and medicinal importance of mushrooms

Fungi have been used for centuries in Asian cultures due to their sensory, nutritional and medicinal properties. Several studies have developed specific activities to understand them, especially the substances involved and their medicinal effects (Cheung, 2010). In addition to improvements in crops, the type of substrate utilized, different forms of conservation and processing, and technological issues such as developing nutraceuticals and functional foods from fungi must be considered (Barros *et al.*, 2008).

Several mushrooms have been recognized as important food sources for their contributions of high-quality protein due to the wide distribution of essential and non-essential amino acids; carbohydrate; dietary fiber; and minerals such as sodium, phosphorus, potassium, iron and zinc (Goyal *et al.*, 2006; Chiu *et al.*, 2000; Mukhopadhyay and Guha, 2015).



Over the years, various therapeutic effects have been reported from some macromycetes, and antimicrobial effects have been demonstrated in fungi such as *Ganoderma* spp., *Pleurotus* spp., *Agaricus* spp. and *Lentinula edodes* on gram-positive and gram-negative bacteria (Alves *et al.*, 2012). Antitumor effects and enhancement or stimulation of the immune system have been reported in *L. edodes*, *Grifola frondosa*, *Agaricus bisporus* and *Pleurotus ostreatus*. In addition, other properties include antioxidant and antidiabetic effects, cholesterol control, treatment for allergies and anti-inflammatory effects, with results comparable to those of commercial medications (Lindequist *et al.*, 2005; Valverde *et al.*, 2015; Khan and Tania, 2012).

Locally, studies have been conducted mainly on *Pleurotus* spp., *Ganoderma* spp. and *Grifola frondosa* to investigate the incidence of variables such as geographical origin, substrates, climatic conditions and physicochemical parameters in obtaining high-value-added bio-compounds such as fatty acids, polysaccharides, terpenes and lignocellulolytic enzymes in addition to the antioxidant activity and bactericidal activity of these substances (Benavides Calvache *et al.*, 2015; Chegwin and Nieto, 2013; Chegwin-Angarita and Nieto-Ramírez, 2014; Nieto and Chegwin, 2008, 2010, 2013; Guzmán *et al.*, 2009; Moreno *et al.*, 2011; Montoya *et al.*, 2012, 2013, 2014; Quevedo-Hidalgo *et al.*, 2012; Quevedo-Hidalgo *et al.*, 2014). Finally, other studies have evaluated various preservation treatments, such as packaging, storage atmosphere and dehydration, to increase the shelf life of *Pleurotus ostreatus* and *Pleurotus sajor-caju* (Castro, 2006; Cortés *et al.*, 2011).

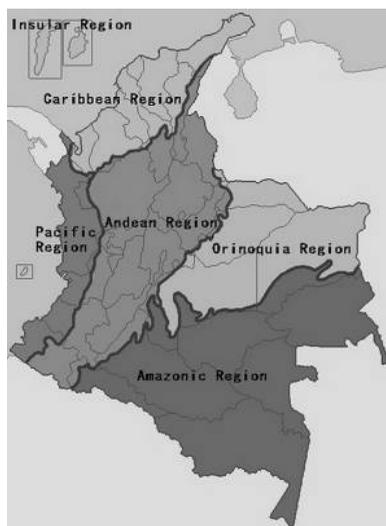
Advances in the cultivation of edible mushrooms and medicinal plants in Colombia, as well as the development of high-value-added compounds and the increase in shelf life, are important for food security and nutrition because mushrooms represent an alternative source of important nutrients such as carbohydrates, proteins, vitamins and minerals, among others. This extends the access to food and availability of nutrients of high biological value for vulnerable communities that have restricted intake and that generally have an environment favorable to producing the raw materials used in mushroom cultivation and to successfully improving the production, processing and consumption of fungi.

### The nutrition situation in Colombia

In Colombia, malnutrition problems that have been identified in adult and infant populations show marked differences according to the development of each region. The main nutritional problems are associated with chronic malnutrition, unhealthy weight and micronutrient deficiencies; the most relevant nutritional deficiencies are in iron, vitamin A and zinc (Fonseca *et al.*, 2011; Neufeld *et al.*, 2010).

#### *Iron deficiency*

Iron deficiency affected 10.6 per cent of children one to four years of age in Colombia, meaning that one of four children have this nutritional problem; for aboriginal children, it is even worse, reaching 19 per cent. Among women in the country, 17 per cent have an iron deficiency, with a higher prevalence between the ages of 30 and 49. As with children, more aboriginal women (22 per cent) have a deficiency than the national average. An interesting fact is that a major insufficiency occurs in urban areas, reaching 20 per cent. The most affected regions are the Caribbean and Pacific regions (Figure 1) (Fonseca *et al.*, 2011). An iron deficiency results in an insufficient supply of oxygen to cells, eventually causing anemia. In the country, this problem affects different groups: in pregnant women aged between 18 and 29, anemia affected 39 per cent; in children between 6 and 59 months of age, it affected 16 per cent; and the indicator increased to 24 per cent in teenagers (Fonseca *et al.*, 2011). To reduce this problem in Colombia, some authors suggest the development and



**Source:** Adapted from <http://commons.wikimedia.org/wiki/File%3ARegionsofcolombia.png> by Z

**Figure 1.**  
Map and regions of  
Colombia

implementation of programs that effectively combat micronutrient deficiencies, given that such shortcomings are related to inadequate dietary intake of iron from animal and non-animal sources (Gaviria and Hoyos, 2011; Manjarrés *et al.*, 2012; World Health Organization [WHO], 2001).

#### *Vitamin A deficiency*

This deficiency affects approximately 24 per cent of children between one and four years of age, affecting mainly the aboriginal and Afro-descendant populations. The most affected regions were the Orinoquia, Amazonic and Andean areas (Figure 1) (Fonseca *et al.*, 2011; Martínez-Torres *et al.*, 2014). These indicators are associated with low socioeconomic status, which implies limited access to high-quality sources of this micronutrient (liver, milk, eggs and fish); the deficiency of public policies focused on the subject is also a problem (Martínez-Torres *et al.*, 2014; Maslova *et al.*, 2009, Mora *et al.*, 1998; Badui, 2006).

#### *Zinc deficiency*

This micronutrient insufficiency is a problem in the country that affects 43 per cent of children between one and four years of age, increasing by over 50 per cent in the aboriginal population (Fonseca *et al.*, 2011). As with the other micronutrients, zinc deficiency in Colombia is associated with a low socioeconomic level; an inadequate diet of the population (low consumption of food from animal sources); and the possible presence of inhibitors of absorption in the diet, especially among the aboriginal population (Martínez-Torres and Ramírez-Vélez, 2014; Castro, 2006).

As discussed above, edible mushrooms and medicinal plants are recognized as important sources of high-quality proteins and also of micronutrients such as iron and zinc, which are

issues of great nutritional importance for the country. This provides a positive outlook for the inclusion of this type of fungi in the diet of the vulnerable populations, considering additional aspects that are explained later.

### **Food insecurity in Colombia**

Food security is considered to exist when a person has physical, social and economic access to sufficient, safe and nutritious food to satisfy his or her dietary needs and food preferences and to lead a healthy and active physical and mental life; the opposite situation is called food insecurity (Food and Agriculture Organization of the United Nations [FAO], 1996, 2003). In Colombia, 42.7 per cent of households are in a state of food insecurity, principally in the Pacific region (Figure 1), which exceeds the national average by over 60 per cent (Fonseca *et al.*, 2011). The main causes of food insecurity are as follows.

#### *Low availability of and access to food*

The reduction of available land for agricultural activity in the past years, associated with internal armed conflict, high rural unemployment, climate change, adverse geographical conditions, insufficiency of the infrastructure and unfavorable market practices has had an impact on family incomes, the rural exodus and food prices and therefore limits the availability of and access to food (González and Quijano, 2007; González, 2010; Villalobos *et al.*, 2013).

Among the recommendations provided by the Organization for Economic Co-operation and Development (OECD) for the construction of agricultural policies in Colombia that could affect food security are increased investment in the transportation infrastructure, improvement in the types of stimulus for the rural sector and an inclusive policy of access to land (Organisation for Economic Co-operation and Development [OECD], 2015). The unequal distribution of land is a major problem in Colombia, represented by a high rural Gini coefficient of 0.89, that greatly compromises primary food production nationwide (Barón, 2013).

#### *Quality control and safety in the food chain*

According to the results of the National Census of Agriculture (National Administrative Department of Statistics [DANE], 2014), nearly half of the population lives in poverty; more than 50 per cent of heads of household have only basic primary education, and more than 80 per cent do not have the appropriate machinery to perform their work. Poor agricultural and manufacturing practices, poor logistics management, poor specifications and fraud in quality control are the ultimate effects of national regulatory deficiencies and weak monitoring and control processes for both domestic and imported products; therefore, there are gaps in consumer protection (González, 2013).

#### *Poor biological utilization of food*

The limited access to education that usually prevails in vulnerable communities, poor eating habits, insufficient basic sanitation and mass advertising promoting the consumption of foods with low nutritional value are factors that impact the inadequate assimilation of nutrients. Likewise, inadequate access to health services, derived from minimal coverage and poor-quality services, can be categorized as one of the main causes of this problem (Bello and Romero, 2001).

In general, the nutritional situation for Colombian children under five years of age is disturbing: 13.2 per cent present chronic malnutrition, 3.4 per cent present global malnutrition and 8.7 per cent present low birth weight; moreover, the average total duration of breastfeeding in 2010 in Colombia was approximately 15 months (Fonseca *et al.*, 2011).

This is a worrying statistic given that exclusive breastfeeding is recommended during the first six months and complementary breastfeeding until the age of two years. This situation demands the development of food security programs coordinated among different stakeholders such as the government, communities and research centers to allow options in access to and availability of food, resources and education, especially for the most vulnerable populations.

### **Inclusion of edible and medicinal mushrooms for nutritionally vulnerable populations**

The introduction of edible and medicinal mushrooms into the diet of vulnerable communities in Colombia may possibly occur in the long term after an arduous process of food acculturation, from the development of programs for food and nutrition security with an interdisciplinary approach to the promotion of consumption and the dissemination of information about mushrooms' nutritional and medicinal benefits. Motivational strategies and educational tools should be used, as well as research and development of new products that include raw materials belonging to the daily diet of local communities, because vulnerable communities with low educational levels could experience some resistance to adding different foods to their daily diet (Ishak *et al.*, 2013).

Cultural acceptability is one of the greatest challenges for this purpose, as promoters must clarify that mushrooms are not intended to replace any food or food groups that make up the national food culture but to extend its capabilities and provide consumer choices. It should be noted that some edible and medicinal mushrooms are an important source of protein, carbohydrate, dietary fiber and micronutrients that are sometimes not found in vegetables at the required levels and also have the advantage of growing in agro-industrial waste areas and in smaller spaces (Salgado *et al.*, 2005; Cheung, 2010). For this purpose, organizational experience in cultivation, transformation and consumption is required, considering the history of the inclusion of *Agaricus bisporus* in the country.

Another challenge is the situations that perpetuate vulnerability, such as the many unmet basic needs in communities, including housing, minimum income and basic sanitation. The latter is related to access to safe drinking water, sewerage and excreta disposal, and inadequate sanitation greatly compromises the conditions that must be guaranteed for the production of mushrooms under the criteria for food safety (Pardo *et al.*, 2013). Under the current conditions of vulnerable communities, there would be an elevated risk of contamination and proliferation of pests during mushroom production. Likewise, given their perishability, fungi can easily deteriorate if adequate mechanisms for conservation do not exist, such as a cooling system for fresh consumption, which also does not exist in some vulnerable communities. Similarly, sun drying entails a risk of contamination because adequate physical protection is not available. The above risks could be mitigated by encouraging partnership and establishing organizational experiences.

This is important if it is assumed that food insecurity in Colombia is derived mainly from economic and social inequities that perpetuate poverty and exclusion in the absence of sufficient income to ensure adequate access to food of sufficient quantity and quality. Therefore, the production of edible and medicinal mushrooms for self-consumption and commercialization could be a viable strategy to increase economic resources that could be reinvested to buy other foods, not only generating greater satisfaction for the producers but also providing the necessary nutrients for them.

The production of macromycetes could be facilitated especially in rural communities, due to the agricultural residues generated in those areas that offer great potential as a culture medium and offer the minimum safety issues to avoid contamination, with raw materials at

very low cost (Rodríguez and Jaramillo, 2005, 2004; Rivera Omen *et al.*, 2013; Vargas *et al.*, 2012). Moreover, the spent substrate can be used as raw material for animal feed, providing sustainability to the process (van Kuijk *et al.*, 2015).

It is important that experiences with a unique approach to self-consumption and food security can be created that do not necessarily ensure the optimal conditions for achieving biological efficiency (relative humidity, temperature, lighting, ventilation, equipment sterilization, rotation of disinfectants, physical barriers to rodent control), but this requires more research to transfer basic technological developments to the communities.

### **Strategy for the implementation of a food security program focused on the consumption and use of edible and medicinal mushrooms**

This section identifies the steps for implementing a food security program, using an approach to the issue of ownership in fungi based on the methodology proposed by Rodríguez and Hesse-Rodríguez (2000).

#### *Identification and demarcation of participating communities*

The first stage requires the identification and demarcation of the work area, focusing on the communities that have the greatest needs with good chances of success to increase the impact on the implementation of the food security program. For this, it is necessary to consult sources of information regarding the successful experiences of previous institutions or to collaborate with organizations that currently develop food security programs, such as local authorities and other organizations relevant to the community and professionals in social and technical areas. This avoids a division of interest, rivalries and conflicting approaches that ultimately cause demotivation in the community.

#### *Needs assessment in food safety*

To assess the needs of the community, it is necessary to conduct an initial diagnosis, which requires building a baseline to determine the most important needs in the field of food security and nutrition. In this way, all the information associated with the following issues is collected: socioeconomic issues, education, information and communications, nutrition, health and basic sanitation, food and vulnerability. This baseline represents a starting point for planning, providing an overview of the problems and opportunities in the targeted area. Subsequently, consultation with the primary sources should be conducted; this phase includes visits to the community and discussion with its leaders and members. The observation should be based on permanent conditions, so the observer must live in the community and be involved in its daily work.

Workshops should be organized that focus on prioritizing problems and analyzing their causes and consequences, differentiating factors such as age and gender and using teaching methodologies that help community members express their needs. This approach helps to improve the population's acceptance and implementation of food security programs.

It is suggested that the needs assessment and programs that promote awareness and motivation regarding the food security program focus on consumption and use of edible and medicinal mushrooms through issues such as:

- the nutritional and medicinal potential of macromycetes;
- the importance of the use of agro-industrial waste; and
- demonstrations of traditional cultivation practices and alternatives, including how to add mushrooms to foods from the local food culture.

*Prioritization and planning*

It is important to prioritize the issues of training and planning the implementation of the cultivation and processing of mushrooms. For this, a participatory action research methodology is used that involves implementing planning workshops and using the logical framework approach and additional techniques such as knowledge dialogue, role playing, observation and group dynamics. This approach generates a greater sense of ownership among the communities so that they become more involved in the project.

*Training and monitoring the implementation process*

This phase of the process should “turn around to the people”. The sustainability of the mushroom cultivation process must be guided by recognition of the popular knowledge, acceptability in the local food culture and optimization of local resources. This goal is not achieved from a vertical system or dogmatic, passive and repressive training. It must be guaranteed by the possibility of rediscovering and using the available resources. It should recognize the potential of people and help to develop creativity, cognitive abilities and potential of creation. This ensures the legitimacy of the process.

The monitoring of the implementation process is achieved through visits to communities and their mushroom “cultivation rooms” to provide practical demonstrations of appropriate knowledge.

*Consolidation of productive experiences*

For the process to be successful, it must be based on “social justice”, a culturally acceptable and sustainable food system and environmentally and economically viable propositions (Pothukuchi, 2004), taking into account the following needs:

- simple and affordable technology that can be selected by the people involved;
- optimal use of the potential of all members of the family;
- the acquisition of knowledge through practice;
- support in the growing and processing of mushrooms;
- emphasis on the fact that there may be a high dropout rate, but the process is only for those who are really convinced; and
- avoidance of welfarism, facilitating material incentives that may generate dependency and conceal the real potential of the communities.

*Emerging leaders and replicators*

The emergence of leaders during the process is significant because they allow better adoption of the program and avoid dependence on outside aid. For this, techniques should be utilized to identify leadership qualities. Subsequently, there must more holistic education and training, based not only on the technique of mushroom cultivation but also on the recognition of the social and individual elements of culture, leadership and other relevant themes. Some responsibilities may be entrusted progressively to the leaders with due assistance; this approach establishes a real link between the facilitator and the leader.

*Transfer of successful experiences*

The knowledge dialogue from family to family and community to community is an extremely valuable and effective methodology for motivation and social cohesion (Sosa *et al.*, 2010). Mushroom cultivation should be equated with productive diversification, improved diet, and progressive improvement in satisfying basic needs. Hence, the challenge and the importance of interdisciplinary and comprehensive development to enhance food security, covering such aspects in broad programs, is evident.

It is necessary to guarantee that people experienced in edible and medical mushroom cultivation and processing can move to other places to multiply the experience or facilitate the exchange of information among the families concerned. Although at present, mushrooms are not part of the food culture of the country, the aim of the program over the long term is to expand this effect in more territories and communities based on the example and successful experiences of the pioneering communities.

A truly inclusive food security program will trigger holistic development, which is evident in greater community organization, greater leadership and expansion of the solutions of various problems. Finally, it is critical to recognize the family as the unit of social life, including its role as the first adopter of organizational processes as a matter of sustainability. These processes are stronger when the family has had successful experiences.

**Conclusions**

The current food problems in Colombia demand joint action involving all stakeholders in food and nutrition security. For this purpose, it is necessary to carry out actions of articulation with local authorities and leaders of communities through a series of strategies that include assessment, planning, training and insertion, especially the recognition of successful organizational processes.

Food insecurity in Colombia will not be overcome only through the promotion of mushrooms, but it is a strategy with immense potential. Fungi are emerging as a low-cost food that is easy to grow and has nutritional and medicinal properties that may help to overcome nutritional deficiencies in vulnerable populations, considering that nutrients such as iron and zinc are main elements of macromycetes.

For edible fungi to become a viable alternative food, it is necessary to develop strategies, food security programs and applied research to evaluate their incorporation into the food culture of communities, considering the acceptability of this food. This requires the promotion of the properties of edible fungi, proceeding from its medicinal and nutritional contributions to its consumption, the marketing of it to fund the purchase of other products and the use of agricultural by-products or waste that could be transformed into food. For that purpose, the contribution of professionals in technical and social areas is required to transfer knowledge to the community, and especially to the community leaders, who have a significant impact on the acceptability of such ideas among the communities.

The establishment of edible fungi in the diet of vulnerable communities may be possible in the long term after an arduous process of food acculturation from the advance of food security programs with an interdisciplinary approach to the promotion of consumption of mushrooms and dissemination of information about their nutritional and medicinal properties, strategies of motivation and pedagogical tools and the transfer of knowledge regarding the basic technological development of the mushroom cultivation process to the community. Cultural acceptability is one of the major challenges for this purpose, including clarification that mushrooms are not intended to replace any food or food groups that make

up the national food culture but rather to expand the food culture's possibilities through the formation of organizational experiences in the cultivation of macromycetes and alternative methods of food preparation and processing. In this way, experiences can be developed with a focus on self-consumption or on the generation of income, which also allow improved food security.

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