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Cultivation of edible mushrooms in Namibia: Prospects and challenges of small scale farmers

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The demand for mushroom cultivation rapidly increases over years in Namibia as more people discovered its health and medical benefits, as well as the mushroom economic value. However, high temperatures at some parts of the country had made the cultivation difficult though watering in the mushroom houses was recommended as a measure to decrease temperature and rise up the humidity in the mushroom houses. In order to exploit the Namibian potential for mushroom cultivation it is essential to develop cultivation technologies for small scale farmers, organized communities before introducing it to modern large-scale industrial operations. In Namibia, there are large amounts of agricultural wastes sometimes, previously, considered to be largely unusable. These agricultural by-products readily available in rural and peri-urban communities can be used as substrate for mushroom cultivation which made the cultivation easier and effective to reduce demand for more food security. Hence in this paper challenges and future prospects of the mushroom cultivation are discussed.

Key words: Mushroom, oyster, agricultural waste, challenge cultivation, prospects.

INTRODUCTION

Strong consumer demands and threats of depletion of mushrooms have stimulated increased worldwide production in the past few decades (Chang and Miles, 2004). The increased demand of mushrooms is due to their unique culinary and medicinal properties (Yan et al., 2004) (cited by Onyango et al., 2011). It provides an efficient and economically-viable biotechnology (Bradley, 2013), which can give consistent growth with high biological efficiency (Jonathan et al., 2012) (cited by Rosmiza et al., 2016). It offers lucrative business requires no arable land for production and provides diversification with benefits such as increased income, employment and food and nutritional security (Gateri et al., 2009). Mushrooms are suitable for fresh consumption, pharmaceutical use and cosmetic production (Ministry of Agriculture Malaysia, 2011; Mohd et al., 2013). Edible mushrooms are highly tradable commodities. The consumption of Oyster mushrooms is reported to boost up the body's immune system as it carries tumor-retarding chemicals (Chang et al., 1993).

Worldwide, edible mushrooms have been widely collected from the forests. The greatly increased harvest of forest mushrooms raises many issues and concerns among forest managers and the general public (Pilz and Molina, 2002; Liegel, 1998) especially within special interest groups, such as mushroom clubs, mycological societies, and conservation organizations. These issues and concerns are directly proportional to wild mushroom depletion that could lead to food insecurity among villagers (Waiganjo et al., 2008). Local mushroom

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cultivation is therefore seen as an adequate solution to secure mushroom supply and to control over harvesting from nature (Fang and Zhong, 2002). According to Chang (2006), the challenge in mushroom production is to recognize opportunities such as increasing consumption capabilities with the increase in world population and to take advantage of this by promoting the consumption of mushrooms. In 2014, Asian countries produced more than 74.64% of mushrooms in the world markets, followed by Europe with 19.63%) (FAO, 2015). However, Africa contributes a paltry >1% of the annual worldwide production of mushrooms (Adejumo and Awosanya, 2005).

Mushrooms are highly nutritious and contain 20-40% protein on a dry matter basis, which consists of all the essential amino acids required in the human diet. Their taste and delightful aroma make them a delicious and popular food in restaurants throughout the world (Mshigeni and Chang, 2000). The abundant agricultural waste found in Namibia offers opportunity for mushroom production. Moreover, spent substrate could be used as animal feed after mushroom cultivation (Soto-Cruz et al., 1999) and as compost to enrich soil for plant production (Szmidt and Chong, 2013). Therefore, the cultivation process of oyster mushroom can address the issue of soil waste disposal, economical gain and environmental protection (Deepalakshmi and Mirunalini, 2014). Cultivation of *Pleurotus* species, commonly known as Oyster mushrooms, is the most popular practice among small-scale farmers; mainly because it can fruit over a wide range of temperatures (Rohde and Hoffman, 2012). The Pleurotus species are regarded as easy to grow and have broad adaptability to the environment in which they grow. This is the reason why their production worldwide has increased rapidly (Chang and Miles, 1997). *Pleurotus sajor caju* and *Pleurotus ostreatus* (oyster mushroom) are two of the choice edible mushrooms which can be cultivated in the tropics (Quimio et al., 1990). Oyster mushroom production represents an opportunity for farmers interested in an additional enterprise and is a specialty option for farmers without much land (Rosmiza et al., 2016).

In general, other edible wild mushrooms are well known among Namibian farmers and are widely consumed in the northern regions during the rainy season (Kadhila-Muandingi, 2010). Although formal scientific mushroom cultivation in Namibia has been attempted in the past and with oyster mushroom identified as easy to grow worldwide, Namibian farmers are still struggling to grow oysters using the locally available materials such as grass, wheat and rice straw and maize cobs. It is now well known that mushrooms can be artificially cultivated in Namibia and many projects are well established across the country. However, the general public especially rural communities have little information on prospects and challenges of oyster mushroom cultivation. The present article reflects on the current status of oyster mushroom cultivation in Namibia to provide views for future direction. The paper assessed the mushroom industry prospects and explored issues and challenges facing the mushroom industry for local and communal farmers specifically. The authors report on the identified challenges and opportunities for mushroom farming, as well as expectations and suggest way forwards toward successful mushroom business enterprises.

MATERIALS AND METHODS

Working methodology

Representatives of different mushroom cultivation projects in Namibia attended a workshop which was hosted by the Zero Emission Research Initiative (ZERI) at the University of Namibia main campus. Nine out of fourteen regions of Namibia were represented. Namely: Erongo, Hardap, Kavango West, Khomas, Ohangwena, Omaheke, Omusati, Oshana and Zambezi regions. ZERI, which is the umbrella of mushroom projects in Namibia, sent out invitation letters to all mushroom projects across Namibia, urging/requesting the project managers to nominate two participants for the workshop. Four Mycological researchers from four different campuses of the University of Namibia were invited. The workshop also included two mushroom experts who have been involved in mushroom cultivation. The workshop also had representatives from the Ministry of Agriculture and the Ministry of Youth, Sport and Culture of the Republic of Namibia, as well as the community development sector. Workshop participants were actively engaged on mushroom production activities at their respective projects. Researchers and Ministry representatives selected were those responsible for mushroom community training in their respective area. Due to language diversity, participants were divided into four groups with a group leader. Each group leader was fluent in the dominant language of that specific group.

Data collection process and analysis

Strengths, weaknesses, opportunities, threats (SWOT) analysis was used as a tool to collect data. Open ended interviews were conducted in a group setting, where questions were posed to the groups and they responded accordingly. Group responses were recorded on paper. The analysis based on current performance such as the role and contributions of the entrepreneur; current total of mushroom production in the country; mushroom and mushroom products exports and imports; and the challenges and opportunities facing growers.

RESULTS AND DISCUSSION

Issues and challenges of mushrooms production in Namibia

Various concerns and challenges were identified that can hamper successful mushroom production among small scale farmers in Namibia, requiring attention and approaches of increased mushroom production and access to market. Challenges such as lack of substrate, community commitments as well as the establishment of favorable mushroom houses require human efforts while

Table 1. Challenges and action required in mushrooms industry of Namibia.

Challenge	Action required
Lack of good substrate	Gather straws during harvesting season of rice and straw and store it.
Access to water	Group leaders to approach town councilors for assistance.
Firewood scarcity	Introduce membership fee to buy wood and substrates.
Contamination of spawn	Maintain good hygiene during spawn inoculation.
Lack of standard mushroom houses	Use locally available materials to construct suitable mushroom houses.
Unavailability of Funds	Apply for funds from non-governmental agencies.
Lack of commitment among project members	Introduce attendance list, assign working shifts, sign performance agreement and dismissal of uncommitted members
High temperature	Water the mushroom house floor, roof and wall frequently when the temperature is high,
Mushroom projects are not well marketed.	Create awareness of project in community. Tell the benefits of mushroom consumption in your area, use media, radio, posters and Television shows etc.
Mushrooms fail to meet market standards	Harvest the mushroom timely to catch good price in the market.

Table 2. SWOT Analysis of mushroom industry in Namibia.

Strength	Weakness
Crop residues such as wheat straw (grown commercially in the southern part of Namibia), rice, pearl millet straws (staple food at the northern part of the country), and rice straw, bamboo and field grasses are readily available for mushroom cultivation	Lack of Government funding on mushroom facilities to produce quality compost, spawn and processed products
Mushrooms provide opportunity to make high value-added products	Short shelf life affecting potential products to long distance markets
Eager market for mushroom produce and products	
Spent mushroom substrate can be recycled on cropping system or as animal feed	Lack of commitments amongst project members
Do not require as much land as compared to other agricultural farming activities	Lack of skilled workers to harvest, grade and package mushrooms for retail.
	Lack of firewood due to conservational laws which prevent cutting of trees.
Threats	**Opportunities**
Contamination of spawn due to substandard facilities	Mushroom consumption awareness created globally on health and medicinal values brought better domestic and global market demand
Pests reduce product quality.	Enhanced public awareness in environmentally friendly farming by using crop waste and spent mushroom substrate as a value-added product will improve future sales. This sentence is not clear
Limited supply of organic pest control products.	Mushroom cultivation is labour intensive, creating job opportunities for unemployed youth in rural and peri-urban areas
Market competition from well-established mushroom producers in neighbouring countries.	The industry creates employment to youth and women in rural and peri-urban areas
Mushroom production is labour intensive. This leads to high production costs	The initiative reduces dependence on mushrooms imports in Namibia

others need government involvement (Table 1).

SWOT Analysis of challenges lining mushroom industry in Namibia

A SWOT analysis was conducted based on the study analysis. There are four strengths that need to be highlighted, with consideration of five significant opportunities for successful mushroom farming in Namibia. In contrast, five scores of weaknesses and five scores of threats must also be fully understood and addressed properly (Table 2).

Table 3. Agricultural residues used to cultivate mushrooms in Namibia.

Residue	Mushroom variety
Wheat straws	Oyster and button
Rice straws	Oysters and button
Corn cobs	Oyster, *Ganoderma*spp*, Lentinuna*spp
Maize straws	Oyster, button
Field grasses	Oyster
Saw dust	*Ganoderma*spp,*Lentinuna*spp
Sawdust – straw mixture	Oyster*, Ganoderma*spp,shiitake
Corn cobs – straw mixture	Oyster*, Ganoderma*spp,*Lentinuna*spp

Agriculture residues as a mushroom growing medium

Wood shavings from local woodworkers are used as a substrate for medicinal mushroom cultivation trials in Namibia. Crop residues such as rice, wheat and maize straws are used to grow oyster mushroom in all regions of the country. New agricultural innovations should be studied to analyze the potential use of other agricultural by-products as substrate (Table 3).

Conclusion

Oyster mushrooms (*Pleurotus* species) are a good choice for beginner mushroom cultivators because they are easier to grow. They can be grown on a small scale with a moderate initial investment. Although commonly grown on sterile straw from wheat or rice, they will also grow on a wide variety of high-cellulose waste materials like millet, sorghum and grass straws that are readily available in most areas of Namibia. The present discussion concludes that, there is high potential of Oyster mushroom production in Namibia and hereby encouraging farmers to utilize the opportunity and grow oyster mushroom.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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