Method to Increase Protein and Micronutrients in Food Staples:Fortification with Nutrient–Enriched Mushrooms Grown on Agricultural Waste

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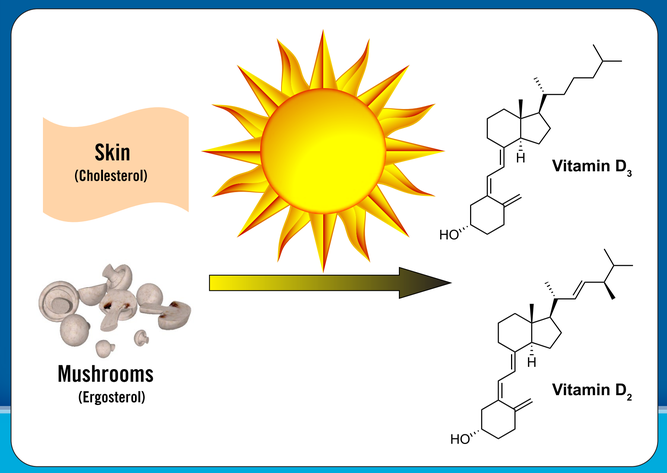
Objectives

The purpose of this poster is to introduce a novel method for multi-nutrient fortification of infant weaning foods through the addition of locally produced oyster mushroom flour which is a naturally rich source of high quality protein and micronutrients critical to immune defense.

Introduction

Vitamin A, iodine and iron are the most limited critical nutrients among poor children in Sub-Saharan Africa who consume a largely vegetable and cereal grain diet. These nutrient deficiencies have been addressed by national supplementation and salt iodination programs and are the impetuses underlying the development of genetically engineered rice and cassava to contain more vitamin A and phytase. There are a number of other nutrient deficiencies which have not been addressed by any of these mechanisms. These other micronutrients, notably vitamin D and selenium, are vital to immune defense in these infants and children.

We propose a multi-nutrient fortification of food staples fed to infants and children using naturally rich high quality protein and micronutrients found in the edible mushroom *Pleurotus ostreatus*, commonly known as the oyster mushroom which would be grown and harvested under specific conditions that markedly increase the content of selenium and vitamin D. Selenium insufficiency weakens cellular immunity and antibody production increasing virulence of viral and bacterial organisms, a mechanism of actions attributed to its function as an antioxidant in seleno-proteins which regulate reactive oxygen species and redox potentials in immune cells. Mushrooms are the only horticultural crop or vegetable source of vitamin D and their content can be significantly increased to the levels that are currently being used to treat tuberculosis and prevent infectious diseases in Western countries. Dark skinned breast fed infants are particularly at risk of vitamin D deficiency because of the low concentrations of vitamin D in breast milk.



Methods

Oyster mushrooms are ideally suited for this concept because they are amenable to small scale, low cost and sustainable technology for bioconversion of numerous agricultural wastes such as coffee pulp, cereal and peanut straw, corncobs or various grasses into nutritious mushrooms. Substrate preparation will vary with the chosen agricultural waste material and can easily be amended by addition of appropriate amounts of sodium selenite to achieve the desired enrichment of the fruiting bodies grown. The substrate will be inoculated with oyster mushroom spawn and then filled into plastic bags (as seen in photos). The bags can then be stored in protected areas until mushrooms are harvested. The harvested mushrooms can then be sun dried to allow the UV portion of sunlight to convert the natural ergosterol in the mushrooms to ergocalciferol (Vit D2). The dried mushrooms are stable enough to be stored until ground into high protein flour enriched with both selenium and Vit D that will be convenient for use for fortification of weaning foods.

Substrate Preparation
(Agricultural Waste Materials)
e.g. coffee pulp
+
Sodium selenite (Na_2SeO_3)

↓ Grow Oyster Mushrooms

Harvest Mushrooms

↓ Sun dry

Dried mushrooms high in Se & Vitamin D_2

↓ Grind

Micronutrient enriched mushroom flour

↓ Add to staple food

Enriched weaning food

Application

The intended application of the nutrient enriched mushroom flour is in the development of weaning foods that combine locally grown grains and vegetable proteins with the high quality protein and B vitamin rich flour made from locally produced oyster mushrooms grown under conditions that markedly enhance selenium content and processed post-harvest by sun-drying to increase vitamin D content. Due to the natural presence of phytase in mushroom flour, it promotes iron and zinc bioavailability. Expressed as mg amino acids per gram of protein, oyster mushrooms have a higher content of sulfur amino acids, threonine and tyrosine than WHO requirements for children 1-10 years of age. Specific to micro nutrient demands of the immune defense system, oyster mushrooms are rich in argentine (91 mg/g protein) which serves as a source of nitric oxide needed for natural killer cell function against invading pathogens, as well as isoleucine, leucine and valine (42, 71 and 57 mg/g protein, respectively). As little as 30 grams of dried oyster mushroom flour could make significant contributions to the daily micronutrient intake of key nutrients needed for mucosal immune defense for breast fed and older infants.

Table 1. A weaning food containing 30 grams of oyster mushroom flour will contribute to the following percentages of Recommended Nutrient Intake (RNI) for children 7 to 12 months of age.

Nutrient	Recommended Intake (RNI)
Vitamin C	20%
Vitamin D2	300%
Vitamin B12	26%
Folate	240%
Selenium	150%
Iron	9%
Zinc	30%
High Quality Protein	64%

Photos courtesy of Dr. Daniel Royse,
Penn State University, Department of Plant Physiology