

Promoting Home Prepared Soy-dishes for Fighting Protein-Energy Malnutrition: Evidence from Demonstration Training

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Abstract

Malnutrition is a persistent problem in developing countries, and protein-energy malnutrition is the worst form of malnutrition associated with lack of energy and proteins. Malnutrition at the early stages of life can lower child resistance to infections, increase child morbidity and mortality, and decrease mental and cognitive achievement. Worldwide the most important step in the treatment of protein energy malnutrition is to correct nutritional imbalances. Increasing the amount of protein in cereal staple foods is the ideal solutions to problem related to malnutrition. Several studies reported that, increased protein content in soybean fortified cereals and tubers, which makes significant contribution towards the alleviation of protein-energy malnutrition. Soybean can be utilized mainly as fermented (e.g., sauce, miso, natto) and non-fermented (e.g., oil, milk, tofu, flour) foods. Therefore, this paper aimed to revise the contribution of home-prepared soy-dishes to combat protein-energy malnutrition.

Keywords: Malnutrition; protein-energy malnutrition; soybean; soy-dishes

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Introduction

Malnutrition is globally the most important risk factor for illnesses and death, affecting especially hundreds of millions of pregnant women and young children (Ezzati *et al.*, 2002). It is a persistent problem in developing countries, especially in rural areas where poor people depend on staple foods and have limited access to a diverse diet. There are several forms of malnutrition and these include two broad categories namely undernutrition and over nutrition. Undernutrition during the first two years of life can lead to stunting (low height for age) and wasting (low weight for height), and consequently to reduced mental and physical capacity later in life (WHO, 2009). It also leads to a higher susceptibility to infections and an increase in mortality due to common infections (USAID, 2016). Malnutrition can also be categorized as being either acute or chronic. Malnutrition is considered acute if it lasts for three months or less before resolving, and malnutrition is considered chronic if it persists for more than three months (Mehta *et al.*, 2013).

Protein-energy malnutrition (PEM) is considered as the worst form of malnutrition associated with lack of energy and proteins (UNICEF, 2013). It is an imbalance between the supply of energy and protein, and the body's demand for them to ensure optimal growth and function. Globally, PEM continues to be a major health burden in developing countries and the most important risk factor for illnesses and death. It is currently the most widespread and serious health problem of children in the world being moderate or severe forms (USAID, 2002). Protein-energy malnutrition is also classified into kwashiorkor, marasmus, and marasmic-kwashiorkor. Kwashiorkor is a form of malnutrition caused by inadequate protein intake, while marasmus is caused by a lack of energy and protein within the diet (Thompson *et al.*, 2008; Manary *et al.*, 2009). Protein-energy malnutrition may be present at any time during the life cycle. Infants and children from developing countries and elderly people from all around the world are the two main groups suffering from protein-energy malnutrition (Lesourd and Mazari, 1997). In developing countries, protein-energy malnutrition problem is ascribed to the inappropriate complementary feeding practices, low nutritional quality of traditional complementary foods and high cost of quality protein-based complementary foods (Eka *et al.*, 2010).

Malnutrition can be sustainably addressed through a cheap strategy of promoting consumption of nutritious foods or strategically blending locally available foods to produce nutrient-dense products (Akanke *et al.*, 2017). Several legumes have been studied and proposed as protein alternatives for human consumption, particularly in developing countries (Kutos *et al.*, 2002). It has been documented that compositing legume proteins with those from cereal and root crops has a complementation effect producing complete and well-balanced amino acid profiles that meet human physiological requirements (Michaelsen *et al.*, 2009). Soybean (*Glycine max*) among legumes is recognized for its high nutritional value as it contains about 40% protein, 20% oil, 23% carbohydrate and 4% minerals (Shiriki *et al.*, 2015). The high nutritional value and low cost of soybean and soy-products make them a suitable solution for malnutrition problems for poor people living on grain centered diets (Serrazanetti *et al.*, 2013). Thus, this review paper was aimed to revisit the benefits of soy-dishes in reducing

protein-energy malnutrition and to indicate the existing opportunities for household consumption of soybean and soy-products.

Prevalence of Malnutrition in Ethiopia

Malnutrition occurs due to an imbalance in the body, whereby the nutrients required by the body and the amount used by the body do not balance (WHO, 2009). The most important documented forms of malnutrition in Ethiopia are protein-energy malnutrition (PEM) and micronutrient deficiencies (vitamin A, iodine and zinc). In Ethiopia, 40.40% of children were reported to be stunted (chronically malnourished) and country ranked 117th of data available in 132 countries about children's stunting prevalence. About 8.70% of children under-five age are wasted (acute malnutrition) and country ranked 98th position of 130 countries in wasting prevalence (Global Nutrition Report, 2016).

Rural areas are more likely to have a higher percentage of stunted children (46%) in comparison to urban environments (36%) in Ethiopia. Amhara has the highest percentage of stunted children at 52% followed by Tigray (51%), Afar (50%), and Benishangul-gumuz (49%) (USAID, 2016). About 25% of children under the age of five are underweight (EDHS, 2014), and 53% of child mortality (under-five years of age) in Ethiopia is attributed to malnutrition. Factors such as improper feeding practices, limited micronutrient dietary selections, and a lack of introducing complementary nutritional foods at appropriate times are the leading causes of malnutrition in Ethiopia (USAID, 2016). Commercially formulated complementary foods are often of high cost thus inaccessible to low-income households. Moreover, animal sources of proteins, which are used to complement the cereal based diets are expensive and out of reach for low-income families (Obatolu *et al.*, 2007).

Soybean and Soy-products: Alternative Protein Sources

Soybean products have emerged as one of the most economical and nutritious foods that can combat diseases ascribed to malnutrition and undernutrition in developing countries (Kumar *et al.*, 2003). A wide variety of soy-foods (non-fermented and fermented) are available throughout the world today. Some are produced by modern processing methods in large-scale plants, and others are still in more traditional ways owing their history to oriental processing methods (Raghuvanshi and Bisht, 2010). Unfermented soybean products include soy-sprouts, immature green soybeans, roasted soybeans, soy-flour, soymilk, tofu, and *okara* while fermented soybean products include miso, tempeh, and soy sauce (Abiose *et al.*, 2015). Soybean contains important macronutrients. Around 40% of the bean is relatively high biological value protein containing all essential amino acids. About the 20% of the bean is composed of lipids (15% saturated fat, 61% polyunsaturated fat and 24% monounsaturated fat) (Cederroth and Nef, 2009).

Table 1. Amino acid compositions of soybean

Amino acid	mg/g protein (dry matter basis)		
	(Fukushima, 1991)	(Friedman, 1996)	(USDA, 2003)
Histidine	27.0	25.4	27.51
Isoleucine	48.0	47.1	49.42
Leucine	78.0	85.1	82.97
Lysine	61.0	63.4	67.85
Methionine + cysteine	65.0	68.1	-
Phenylalanine + tyrosine	90.0	96.6	91.80
Tryptophan	13.0	11.4	14.82
Threonine	35.0	38.4	44.28
Valine	48.0	49.1	50.88

Source: Fukushima, 1991; Friedman, 1996; USDA, 2003

Soy protein quality is equivalent to that of livestock proteins (meat and milks) in terms of protein digestibility corrected amino acids score (PDCAAS), and is superior to other plant proteins (Giri and Mangaraj, 2012). Soy protein is also effective in lowering total cholesterol as well as low-density lipoprotein (LDL) cholesterol (Anderson *et al.*, 1995). The consumption of soybean products containing soy protein has risen in recent years (Giri and Mangaraj, 2012). Soybean proteins are used in human foods in a variety of forms, including infant formulas, flours, protein isolates and concentrates, and texturizing fibers (Singh *et al.*, 2000). The high nutritional value and low cost of soybean products make them a suitable solution for malnutrition problems for poor people living on grain centered diets (FDA, 2004). Evidence also suggests that soy-based complementary foods have played a reputable role in reducing protein energy malnutrition among African children (Muhimbula *et al.*, 2011; Onoja *et al.*, 2014). Soybean flour and soybean protein has been used as composite flour in the production of bread (Olaoye *et al.*, 2006), missi roti/chapatti (Kadam *et al.*, 2012) and biscuit (Oluwamukomi *et al.*, 2011). Mosha *et al.* (2010) reported that, soybean composite crackers have also been developed as energy dense healthy snack for school-children.

Demonstration and Popularization of Soybean-dishes

Because of its high protein content and low price, soybean and its products are considered as an aid in solving world food problems. For thousands of years, soybean has been a staple of the Asian diet, but over recent decades, consumption is quickly growing worldwide (Lokuruka, 2010). In Ethiopia, soybean is adapted to diverse ecological niches and provided wider yield range. Currently, the production is steadily growing to meet the ever-increasing food and market demands of this crop in the country. Soybean could be an alternative protein source to the rural families and can be utilized at home in various forms (Ambitsi and Oucho, 2007). Different soybean-based products; soymilk, soy-cheese, *wot* (stews), *kitta* (unleavened bread), *dabbo* (traditional bread), *dabo-kolo*, *injera* (fermented flat bread), fried *okara* and other products have been prepared and demonstrated successfully in Metekel Zone and Jawi Districts.

Table 2. Different types of soybean-based dishes prepared at home level

No.	Soybean-based dishes	Preparation methods
1	Soymilk	Cleaned seeds will be blanched for 10 mins and soaked in water (soybean: water ratio 1:3, w/v) overnight at room temperature. Hydrated beans will be drained, rinsed and de-hulled manually, then wet-milled with the hot water (soybean: water ratio 1:8, w/v). The slurry will be cooked for 15 mins and filtered using cheese cloth and boiled for another 10 minutes and cooled. Then, ready for consumptions with sugar, salt and spices (rue, cinnamon and clove)
2	Soy-cheese	First soymilk will be prepared according to the above procedure, and then the temperature will be waited till lowered to 75°C. Then, about 100 ml of filtered lemon juice will be added for about 1000 ml of soymilk as a coagulant. Once stirred the mixture will be kept until coagulated. Then, the mixtures will be poured over muslin cloth and the liquid will be pressed out.
3	Soy-teff blended injera	First soybean and teff mixed flours will be prepared in 20:80 ratio (soybean: teff). About 300g soy-teff mixed flour (240g teff + 60g soy) will be taken, and mixed with 40g <i>irsho</i> and 1000ml water. Then, allowed to ferment for 50 hrs. After primary fermentation, about 300ml hot water (absit) will be added and mixed. Then, allowed to cool for about 30 mins and 180 ml water will be added, and waited for secondary fermentation. Then, it will be baked following traditional injera baking procedure.
4	Soy-wheat blended bread (<i>dafo-dabo</i>)	By taking soybean and teff mixed flour in prepared 25:75 ratio (soy: wheat), traditional bread can be prepared following the traditional <i>dafo-dabo</i> making procedure.
5	Cookies, <i>dabo-kollo</i> , <i>kitta</i> and <i>chechebsa</i>	Soy-wheat blended cookies, <i>dabo-kollo</i> , <i>kita</i> and <i>chechebsa</i> also can be prepared by mixing soybean and wheat flour in 1:3 ratio (50g soy + 150g wheat flour) in home level following traditional procedure.
6	Soy-finger millet blended porridge	About 40g soy-flour and 160g finger millet flour (20:80) will be mixed and cooked in 500ml hot water following traditional procedure and possible to consume with butter/oil and pepper.
7	<i>Okara</i>	<i>Okara</i> is the insoluble fibrous material from filtered soymilk. It can be fried and consumed using oil with carrot, kale, onion and other spices.

Practical training on how to prepared common and traditional food products by blending soybean with other cereal grains was given for selected participants from *jawi*, *pawe*, *mandura*, *dangur*, and *dibate* woredas. On the training session 36-female farmers, 4-male farmers and 4-AHEW (Agricultural and Health Extension Workers) from *jawi* woreda, 27-female farmers and 26-AHEW from *pawe* woreda, 44-female farmers and 4-AHEW from *mandura* and *dangur* woredas, and 27-female farmers and 3-agricultural extension experts from *dibate* woreda were participated.

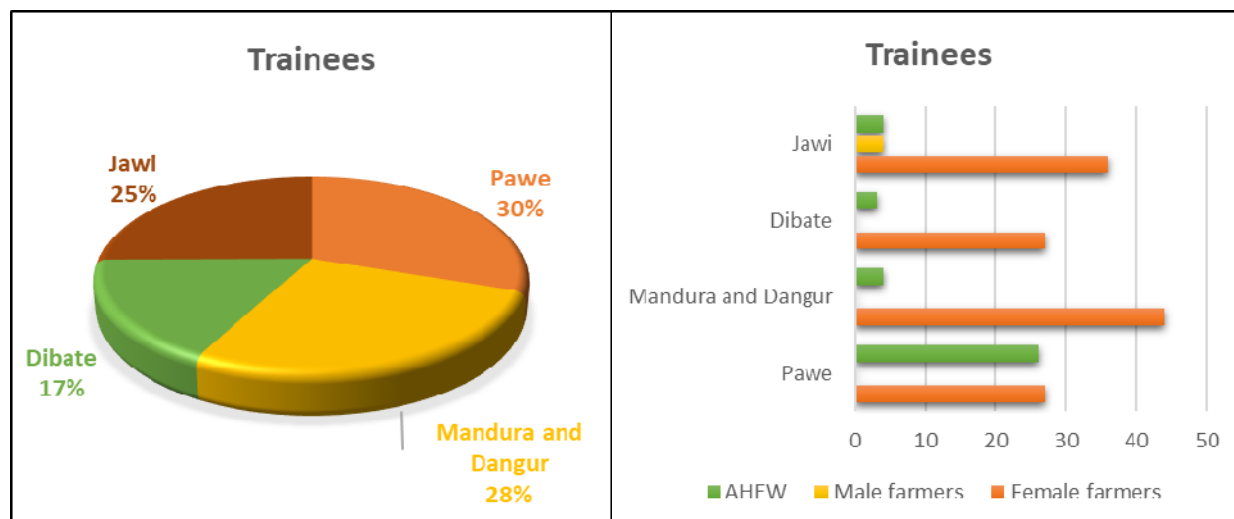


Figure 1. Participants on soy-dishes training

Conclusions

Protein deficiency and malnutrition is a well-documented cause of ill health and death in developing countries. The causes are numerous and multifaceted but the immediate determinants are poor diet and disease. Food-based strategies favoring local multi-nutrient food materials have been reported to be the best suitable and sustainable approach for combating protein malnutrition. Thus, soybean is easily available, cheap, and a rich source of protein for poor farmers, who have less access to animal source protein due to their low purchasing capacity. In extension program, different soybean-based food products were prepared and demonstrated, and farmers (male and female), agricultural and health extension workers were also trained how to prepare soy-dishes at home level. Promising result was observed, and further promotion of soy-dishes for household consumption is important to tackle malnutrition related problems.

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Figure 2. Practical training on how to prepared soy-based dishes at home level