The role of legumes for sustainable eating

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Gastronomy- Sustainable Eating
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1. Introduction

Food production and consumption has been identified as one of the most important drivers of environmental pressures, especially in respect of habitat change, climate change, water use and toxic emissions (UNEP, 2010). Food from animal origin are far more land and energy intensive compared to food of vegetable origin (Garnett, 2009). Livestock production occupies 80% of global agriculture land and is estimated to account for more than half of the greenhouse gas (GHG) emissions attributable to agriculture (FAO, 2009, Steinfeld et al., 2006). Due to population growth and increased consumption of meat and dairy products global demand for animal products is projected to double by 2050 compared to in 2000 (Bruinsma, 2009). Dietary change, with reduction in livestock consumption as a major element, has been suggested to be a necessary measure of mitigating climate impact from the food sector (Carlsson-Kanyama and Gonzalez, 2009, Garnett, 2011). Reduced consumption of meat in regions with affluent diet could imply multiple benefits including reduced environmental impact and positive effects on health (Foresight, 2009, Gibney, 2009).

Legumes are plant-based alternatives to animal products with low environmental impact.

1.1 Objectives

The objectives of this report are to:

I) Describe the environmental impact and nutritional content of legumes

II) Discuss the opportunity of increasing sustainability in western diet by increased consumption of legumes
2. Environmental impact of legumes

2.1 Production
The greatest environmental impact of food production is in general associated with the primary production (Foresight, 2009, Sonesson et al., 2010). Also for production of legumes cultivation, along with cooking, is responsible for the majority of GHG emissions and energy consumption (Biel, 2006, Olsson, 1998). Production of fertilizers, nutrient leakage from manure and fertilizers and use of diesel for agricultural operations are examples of elements in cultivation contributing to negative environmental impacts (Hallström, 2009).

Introduction of legumes into the crop rotation has been shown to bring many environmental benefits including reduced energy use, global warming potential, ozone formation, acidification and eco toxicity (Kopke and Nemecek, 2010, Nemecek et al., 2008). Legumes ability to fix nitrogen and thereby reduce the dependence on mineral fertilizers is the main reason for improved environmental performance (Nemecek et al., 2008). Production of mineral fertilizers generates emissions of carbon dioxide and nitrous oxide and is thus an important contributor to GHG emissions in agriculture (Sonesson et al., 2010). The ability to fix nitrogen makes rotational cropping systems and intercropping with legumes especially suitable for organic production where the use of chemical fertilizers is forbidden. Reduced need for pesticide application and tillage are additional ecological benefits associated with crop rotation with legumes. Increased nitrate leaching and risk for eutrophication are negative effects associated with introduction of legumes (Kopke and Nemecek, 2010, Nemecek et al., 2008).

The soya bean has due to its special properties become an important oil and protein crop and its global production has more than doubled during the past 20 years (FAO STAT, 2011). The soya bean origins from Asia but today the main production is found in the United States and in South America (Brazil, Argentina and Paraguay) (FAO STAT, 2011). Production of soya
in South America has been identified as a primary driver for deforestation in Amazonas resulting in high emissions of greenhouse gases and loss of biodiversity (Nepstad et al., 2006). The loss of forest in the Amazon attributed to soy production has been estimated to 1.2 million hectares per year (Naturskyddsföreningen, 2010). To reduce environmental impact from soya cultivation standards for increased sustainability are developed by the organization of Round Table of Responsible (Round Table of Responsible Soy Association, 2011).

2.2 Consumption

Life cycle analyses have shown that legumes have low environmental impact compared to other protein rich foods (Carlsson-Kanyama and Gonzalez, 2009, Davis et al., 2010, González et al.). Gonzalez et al. (2011) showed that legumes of different types and origin consumed in Sweden result in GHG emissions between 0.38-1.3 carbon dioxide (CO₂) equivalents per kilogram. This can be compared with emissions from chicken, pork, cheese and beef with emissions ranging from 2.9 to 40 CO₂-equivalents per kilogram. It has further been argued that legumes deliver 6-14 times more protein per used MJ and 4-40 times more protein per emitted CO₂-equivalent compared to different types of meat (González et al.). Air transported and highly processed legumes have higher environmental impacts compared to conventional dried, preserved or fresh legumes (Carlsson-Kanyama et al., 2003, Davis et al., 2010).

Several studies have estimated the climate impact of different food patterns by translating the climate impact and consumed amounts of different foods to complete meals and diets. The overall conclusion is that a shift towards less animal based and more plant-based diets, rich in legumes, would be beneficial from both a climate and overall environmental perspective (Baroni et al., 2007, Carlsson-Kanyama, 1998, Carlsson-Kanyama et al., 2003, Carlsson-Kanyama and Gonzalez, 2009, Davis et al., 2010, González et al., Pimentel and Pimentel, 2003, Reijnders and Soret, 2003). An environmental assessment performed by the Swedish Food Authority concluded that legumes, due to their low environmental impact in production
and long durability (dried legumes), is a sustainable food choice and that increased consumption of beans, peas and lentils can reduce the environmental of diet especially if the consumption replaces meat intake (Lagerberg-Fogelberg, 2008).

3. **Nutrition and health**

3.1 Nutrient content of legumes

Balanced nutrition is a major determinant for maintaining health and preventing non-communicable diseases (Gibney, 2009). Healthy dietary pattern is, according to current scientific evidence, characterized by a high intake of fruits and vegetables, legumes, oily fish, whole grains and nuts, a limited intake of mainly low-fat meat and dairy products and a low intake of snacks, sweetened drinks and other foods with low or without nutritional value (WHO, 2004, WHO/FAO, 2003).

Legumes are characterized by a high content of protein, fibre and micronutrients and low fat content. The protein content of legumes is generally between 20-30 % of energy which corresponds to levels found in fish and meat. Protein quality of legumes is lower compared to foods of animal origin, mainly due to their limited content of the two sulfur-containing amino acids methionine and cysteine (Messina, 1999). To improve protein quality, legumes can be eaten with cereal grain products which have a complementary amino acid composition (Swedish Food Authority, 2011). Beans, peas and lentils are good sources of dietary fibre and have low glycaemic index (Messina, 1999) which is associated with various health benefits including improved metabolic control and decreased risk for cardiovascular disease, obesity and diabetes (Mann et al., 2007). Legumes are rich in many vitamins and minerals such as iron, zinc, magnesium, calcium and folate. Like other fibre rich foods legumes contain phytate and other components which reduce bioavailability of minerals. To increase absorption of iron legumes should be consumed together with vitamin C. Legumes also contain components which can interfere with digestion and create discomfort if not properly cooked. After correct
coking, which often means that legumes are both soaked and boiled, the content of such components will be reduced to insignificant and harmless concentrations. It is well-known that consumption of legumes can increase flatulence. The gas production is as a result of oligosaccharides that are fermented by bacteria in the colon. The fermentation is thought to promote health in colon but may cause social inconvenience (Messina, 1999).

3.2 Dietary recommendations
Dietary patterns in regions with affluent diet are generally too high in energy dense food and too low in fibre rich food, resulting in an excessive intake of total fat, saturated fat, free sugars and salt, and an inadequate intake of fibre, complex carbohydrates and micronutrients (Kearney, 2010, Popkin, 2006, Srinivasan et al., 2006). Desirable changes for meeting dietary and health recommendations in regions with affluent diet include; an increased intake of fruit and vegetables, legumes, cereals (in particular whole grains), fish (in particularly oily fish), and a reduced intake of dietary fats, sugar, meat and fatty dairy products (Srinivasan, 2007, Srinivasan et al., 2006).

Consumption of legumes has been associated with lower serum cholesterol concentrations and reduced risk for coronary heart disease, diabetes and obesity (Leterme, 2002). Swedish dietary guidelines therefor recommend an intake of half a decilitre cooked legumes per day which is three times more than current consumption in Sweden (Naturskyddsföreningen, 2010, Swedish Food Authority, 2011).

4. Challenges and opportunities of dietary change
Increased consumption of legumes is a sustainable option both in terms of reducing environmental impact from the diet and by improving health, especially if replacing foods with high environmental burden and/or foods that are excessively consumed.
Today, there is substantial knowledge of how we can eat in a healthy way. Despite this, few people follow dietary advice that has been developed and overweight and diet-related diseases is a growing problem affecting one third of the world’s adult population (Kelly et al., 2008). Food is eaten for many different reasons and has values others than to make us fed and stay healthy. To eat is a way of expressing cultural habits and social status, a way to enjoy, reward yourself and to socialize with others (Hoek and 2010). To change eating habits towards more sustainable food choices there is a need to increase the knowledge of why people make certain food choices (Gibney, 2009).

Fundamental changes throughout the food system may be needed to increase demand for legumes and other foods with high nutritional value and low environmental impact (Blay-Palmer, 2008, Foresight, 2009). Economic growth is associated with an increased demand for animal products and for food that is more processed (Foresight, 2009). Development of novel protein products, entirely based on plant protein or with partial substitution of meat protein by plant protein, has been suggested as an opportunity to increase consumer acceptability for more sustainable sources of protein (Aiking, 2010, Carlsson-Kanyama and Gonzalez, 2009, Hoek and 2010, Smil, 2002). Legume based food products, such as tofu, tempeh and falafel, are traditional meat substitutes which have been eaten for centuries in Asia and the Middle East. During the nineties plant-based meat substitutes have become increasingly available also on the European market but they still account for a small share of the market (1% of the market share in Netherlands, 2002) compared to conventional meat products (Hoek and 2010). The food industry has an important responsibility to increase the production of foods that are nutritious, healthy and have low environmental impact. At the same time changes are required at many levels in the society to increase the status and consumer acceptance of such foods. The common benefits of legumes for overall health and the environment suggest that
legumes will have an important role in the development towards sustainable food consumption and production.

5. Conclusion

Dietary change towards increased consumption of plant-based products would be beneficial from both a health and environmental perspective. The common benefits of legumes for overall health and the environment suggest that legumes will have an important role in the development towards sustainable food consumption and production.

6. References

Garnett T (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? Food Policy. Vol. 36, pp S23-S32.


