



Determination of Carbon Footprint of Selected High Protein Foods

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KEYWORDS

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ABSTRACT:

Introduction: One of the biggest difficulties of the twenty-first century is to feed nine to ten billion people sustainably by 2050 while minimising environmental effect (such as greenhouse gas (GHG) emissions, biodiversity loss, land use change, and loss of ecosystem services). In recent years, societal emphasis has been focused on the environmental effect of food consumption. Pressure on the environment is rising as food consumption rises.

Objectives: Therefore this study was carried out with the objective to determine the carbon footprint of high protein foods and to create awareness among public about the environmental effects by high protein food (Non-vegetarian foods).

Methods: Carbon dioxide (CO₂) is the most significant Green House Gas emitted by food intake, followed by methane (CH₄) and nitrous oxide (N₂O). CO₂ emissions occurred during agricultural activities, farm input production, transportation, processing, and food preparation. The carbon footprint of the foods was determined per year.

Results: The study result highlights that meat and dairy have a high carbon footprint which should be avoided followed by lightly processed dairy (such as yogurt, butter and cheese) have a medium carbon footprint and has been recommended rarely. Pulses had low effect on environment were also high on protein and recommended without any restrictions.

Conclusions: Knowledge about the carbon footprint of food has the potential to impact sustainable transformation procedures in the crucial field of nutrition. Future decision-making to include environmental sustainability in nutrition advice can be aided by understanding the carbon footprints of various suggestions.

1. Introduction

Over the past 10 years, plant-based nutrition has attracted a lot of interest (Feher *et al.*, 2020). In the ecological discussion on whether to promote more sustainable sources, the demand for naturally high-protein meals is on the rise (Cramer *et al.*, 2017). Concerns about both health and the environment are brought up by the large percentage of animal protein consumed in affluent nations (Fresan *et al.*, 2018). The environment is under more pressure as food consumption rises. Research on how food consumption affects the environment often focuses on energy usage

and trash creation, with little attention paid to greenhouse gas (GHG) emission. The most significant GHG resulting from food intake is carbon dioxide (CO₂), followed by methane (CH₄) and nitrous oxide (N₂O) (Kramer *et al.*, 2009).

The entire amount of GHGs emitted by a product is known as its carbon footprint. It is frequently represented as the carbon dioxide equivalent of all released GHGs. A GHG emissions assessment can be used to determine a product's carbon footprint. Once a carbon footprint's size is established, a plan may be developed to minimise it through technological



advancements, improved process and product management, and alternative consumption patterns. The manufacturing, transportation, processing, and preparation of food items are only a few of the processes that result in the emission of GHG. A sizable portion of the world's total GHG emissions are caused through food chains. According to Steinfeld *et al.* (2006), animal products alone are responsible for 18% of worldwide GHG emissions.

Protein is a dietary macronutrient that plays a wide range of structural and functional roles in the body. Large molecules known as proteins are composed of chains of amino acids. In a nutshell, digestion converts them into amino acids. Amino acids perform essential tasks; for instance, some are utilised for neurotransmission (Layman *et al.*, 2015). In order to provide energy for our body, amino acids can be further broken down (Sakami *et al.*, 2013). Finally, they may also be put back together by the organism to create various types of proteins that perform a variety of other crucial tasks in our body (Layman *et al.*, 2015). In other words, without proteins, human existence is not conceivable.

All nine indispensable (necessary) amino acids are present in protein sources such as meat, chicken, fish, eggs, isolated soy protein, and dairy products (milk, cheese, and yoghurt), which are regarded as high-quality protein sources. Plant, legume, grain, nut, seed, and vegetable proteins may be lacking in one or more essential amino acids, hence these foods are regarded as lower-quality sources of protein (Feher *et al.*, 2020).

This industry accounts for 18% of all GHG emissions in India (INCCA, 2010). Methane emissions from enteric fermentation in ruminants (63%) and rice fields (21%), nitrous oxide emissions from applying nitrogen fertiliser and manure to agricultural soil (13%) and manure management and burning of crop leftovers (2.7%) are the main sources of emissions from agriculture.

2. Objectives

Therefore this study was carried out with the objective to determine the carbon footprint of high protein foods and to create awareness among public about the environmental effects by high protein food (Non-vegetarian foods).

3. Methods

Selection of samples

According to NIN (2011), the amount of protein needed depends on age, physiological condition, and stress. Infants and children who are growing, pregnant women, and people who are unwell or under stress all need more protein. So, the selected foods are good source of proteins like pulses and animal foods like milk, egg, meat products and fish.

Carbon footprint

The total amount of greenhouse gases produced over the course of a product's life cycle is known as the "Carbon Footprint." Although the Carbon Footprint has gained popularity and is widely acknowledged in scientific and industrial circles, it must be augmented by utilising a thorough input indicator to analyse biotic and abiotic material fluxes over a longer time horizon (Schmidt, 2008).

The carbon footprint of the selected foods were calculated per year by using the formula,

$$\text{Carbon footprint} = \text{Consumption of items / day (kcal/day)} \times 365 \times \text{Emission factor (kgCO}_2\text{/kcal)}$$

Whereas here,

Consumption of items / day (kcal/day) – The energy in kcal of selected food items consumed by the subjects, the energy was calculated for each food items using IFCT nutritive value book (2017).

365 – Number of days in a year

Emission factor – Adjusted daily emission factor for a particular harvested area.



4. Results

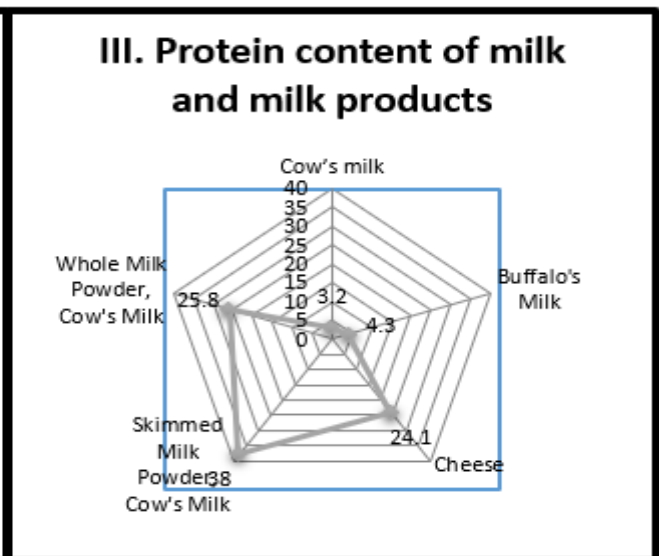
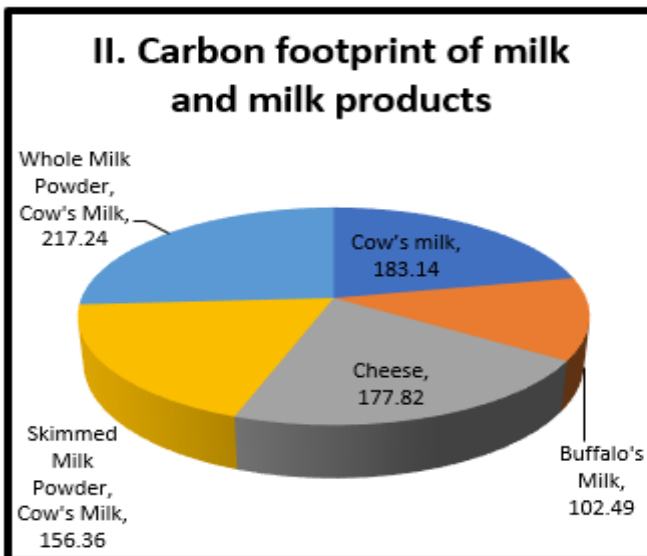
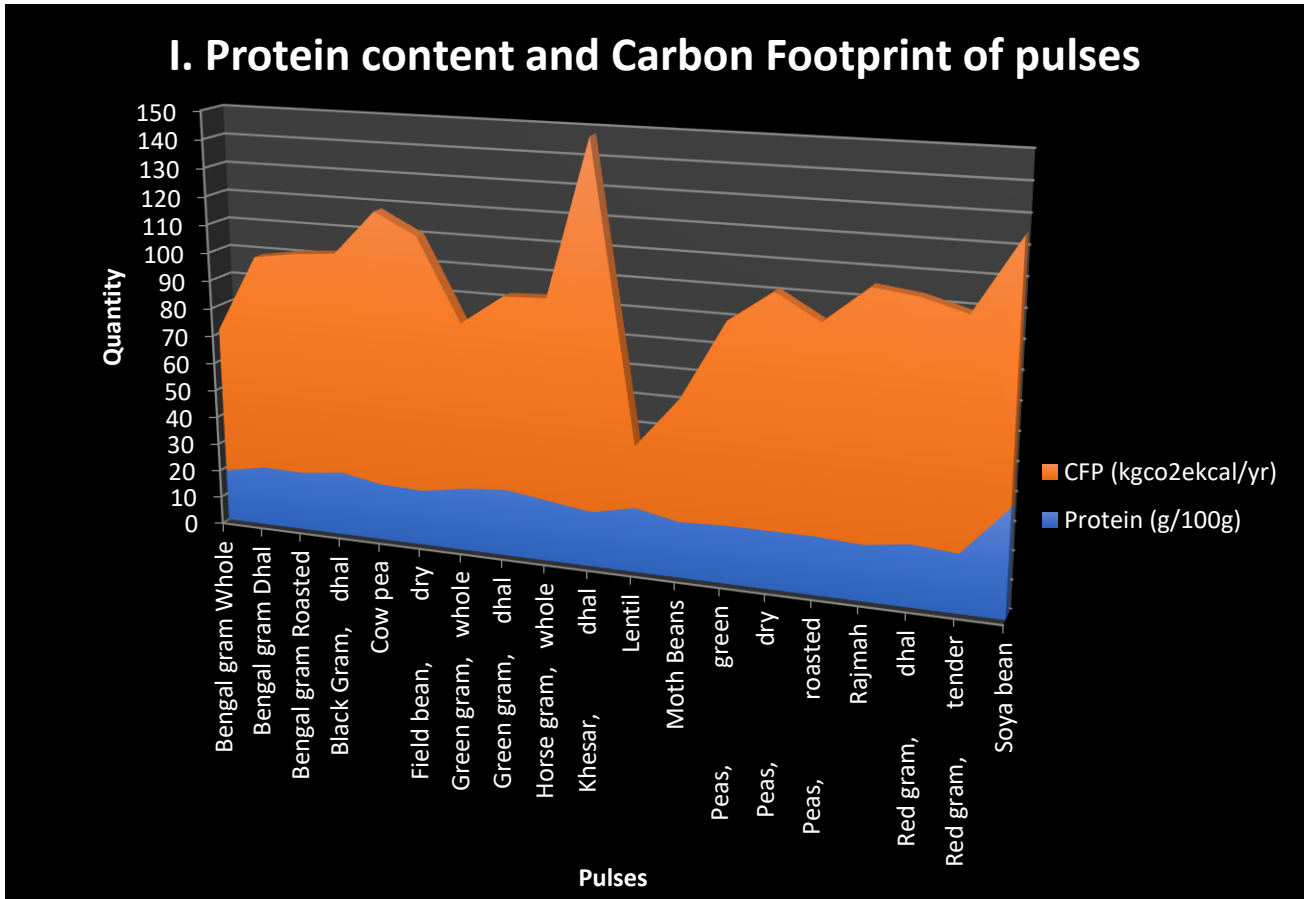


Figure: I Comparison of protein content and carbon footprint of pulses



From Figure I, it was clear that carbon footprint of Khesar dhal (128.36 kgco₂ekcal/yr) was higher when compared to other pulses followed by cowpea (97.68 kgco₂ekcal/yr) whereas protein content of that were 19.50g and 20.36g respectively. The least carbon

emission among pulses were found in lentil which was 21.78 kgco₂ekcal/yr which was followed by moth beans (42.90 kgco₂ekcal/yr) and their protein were 22.87g and 19.75g respectively.

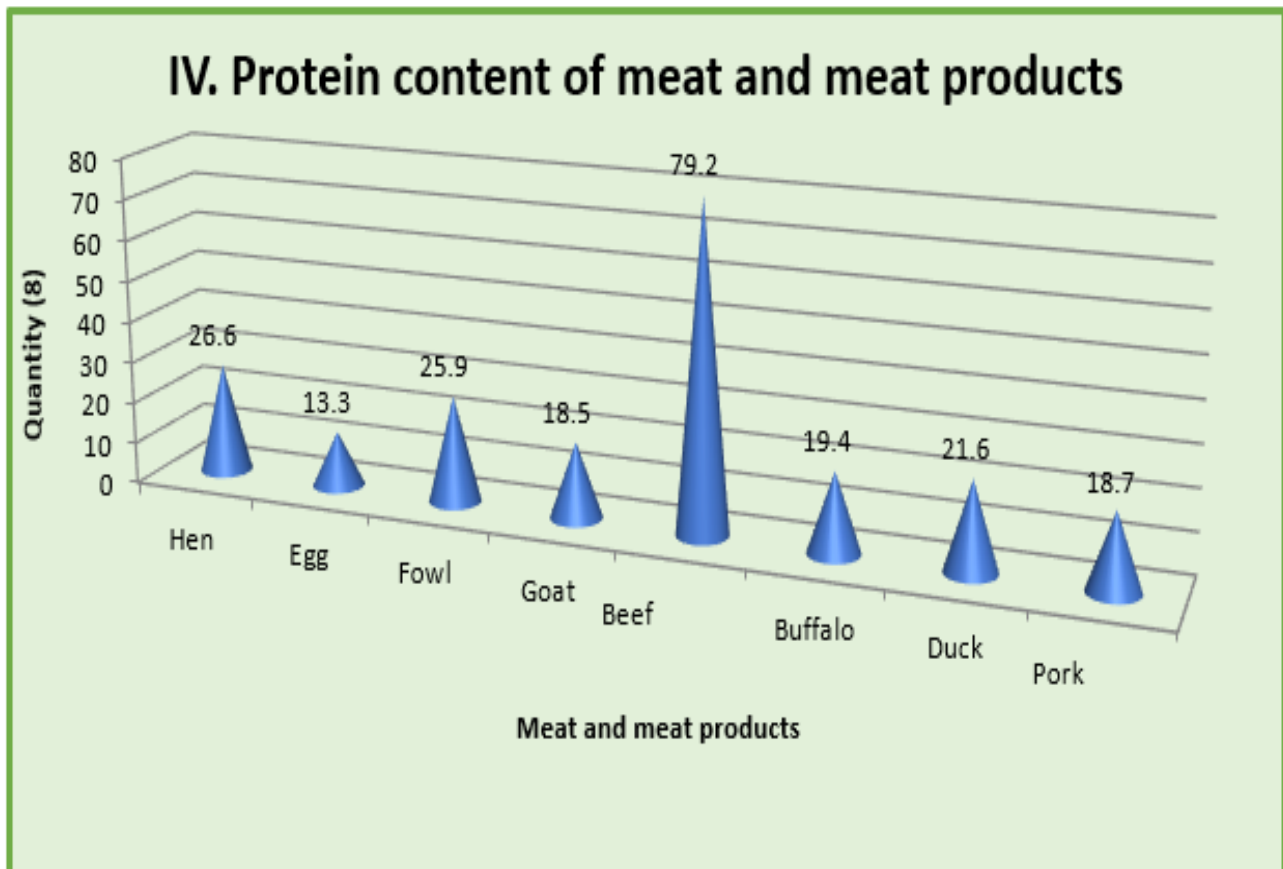


Figure IV Protein content of meat and meat products

Figure IV shows the protein content of meat and meat products which was clear that beef (79.2g) contains more protein followed by hen (26.6g) and fowl (25.9g). Egg (13.3g) has low protein compared to other meat products followed by goat (18.5g) and buffalo (19.4g).

Figure II and III Comparison of protein content and carbon footprint of milk and milk products

Figure II and III depicts the comparison of protein content and carbon footprint of milk and milk products, whereas the protein content of skimmed milk powder was higher and cow's milk was lower. But when compared, the effect of buffalo's milk on

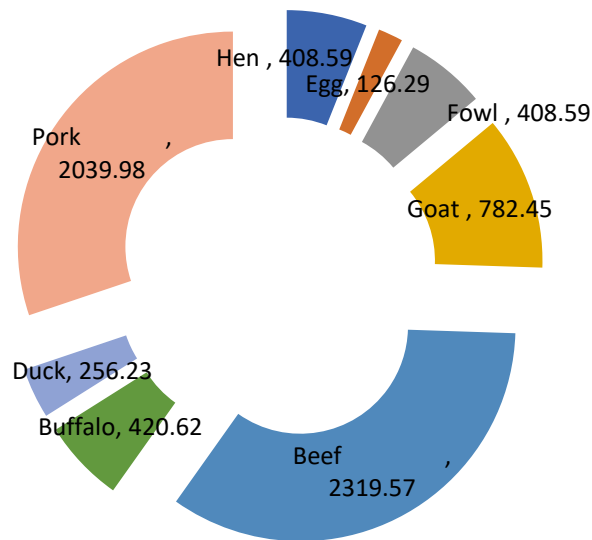
environment was lower and whole milk powder was higher.

Figure V Carbon footprint of meat and meat products

Figure V clearly shows that when compared all the other meat products egg (126.29 kgco₂ekcal/yr) has less impact on environment followed by duck (256.23 kgco₂ekcal/yr). among the meat products beef (2319.57 kgco₂ekcal/yr) has higher impact on environment and followed by pork (2039.98 kgco₂ekcal/yr).



V. Carbon footprint of meat and meat products



VI. Protein content and Carbon footprint of high protein foods

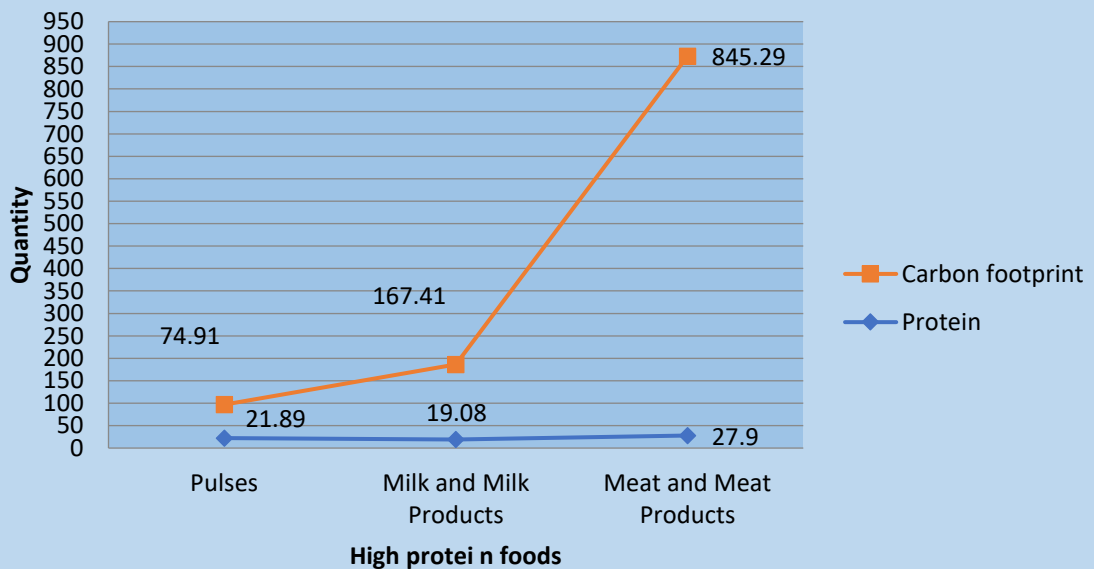


Figure: VI Comparison of Protein content and Carbon footprint of high protein foods



Figure : VI highlights the Comparison of Protein content and Carbon footprint of high protein foods. It shows that the protein content of meat and meat products were higher compared to pulses and milk and milk products. The carbon footprint of meat and meat products were very much higher followed by milk and milk products. But, pulses had the low effect on environment and hence recommended without any restrictions.

5. Discussion

When it comes to food, pulse crops clearly outperform all other food groups in terms of both carbon and water footprints (Gephart *et al.*, 2016; Scarborough *et al.*, 2012; Song *et al.*, 2016). Diets with larger amounts of plant-sourced vs animal-sourced proteins have been shown to have lower carbon footprints (Heller & Keoleian, 2014; Tilman *et al.*, 2011; UN, 2016).

During recent years, the livestock sector has been revealed as one of the main contributors to climate change, representing 18% of anthropogenic greenhouse gas (GHG) emissions (Steinfeld *et al.*, 2006). This number has further been disaggregated, showing that the dairy sector² (including meat by-products) is responsible for 4.0% of global emissions. If emissions are divided between dairy products and by-products (i.e. beef), dairy products represent 2.7% of global GHG emissions (Gerber *et al.*, 2010).

The largest environmental burden for animal food products is created at the primary production stage. For dairy products in industrialised countries about 80% of GHG emissions occur before the farm gate. As a global average, the GHG emissions amount to 2.4 kg carbon dioxide equivalent (CO₂e) per kg milk at farm gate (including emissions for transport and processing). There is a significant variation between regions; from approximately 1.5 kg CO₂e per kg milk in Europe, North America and Oceania to 7.5 kg CO₂e per kg milk in Sub-Saharan Africa. In Northern Africa, Asia and Central and South America the emissions are between roughly 2 and 5 kg CO₂e per kg milk (Gerber *et al.*, 2010).

6. Conclusion

The results show that ruminant meat and dairy have a high carbon footprint per g of protein; while other meats (such as pig and poultry) and protein-rich, lightly

processed, dairy (such as yogurt) have a much lower carbon footprint. According to this study, changing one's eating habits presents opportunities to reduce greenhouse gas emissions. Choosing food products that have less of an impact on the environment might be one strategy for lowering GHG emissions. Locally produced foods, decreased mutton consumption, and the replacement of meat and milk with alternative plant proteins are some strategies to cut down on the GHG emissions caused by food consumption. However, when substituting food products with nutritional benefits (vitamins, proteins, and minerals) are just as significant as calorific value and GHG emission.

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