# PLANT-BASED MEAT PRODUCTS IN BRAZILIAN MARKET: EVALUATION OF THE INGREDIENTS AND NUTRITIONAL VALUE

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## I. INTRODUCTION

Numerous discussions involving environmental aspects, animal welfare, and effects on health in relation to livestock and the consumption of red meat have driven the search for new protein sources, such as plant proteins [1]. In this view, plant-based meat products (PBMP) have been developed and marketed worldwide. These products attempt to mimic the sensory, chemical, and functional qualities of meat and meat products. However, nutritionally they are not necessarily the same as traditional meat products [2]. Thus, this study aimed to analyse the plant-based meat substitutes currently available in the Brazilian market, having as main topics of discussion the ingredients and nutritional value.

## II. MATERIALS AND METHODS

This study examined the label of 59 PBMPs sold in three leading supermarkets in Brazil. PBMPs products were grouped into seven categories (meat/chicken, hamburger, meatball, kibbeh, breaded, sausage, and hot dog) according to the terminology printed on their respective labels. The products had their ingredients subdivided according to their function (nutritional or technological) and the frequency (%) of each macronutrient source was calculated. Regarding the nutritional value, we proposed a comparison with the Brazilian legislation on traditional meat products (TRIQ - Technical Regulations of Identity and Quality, Ministry of Agriculture, Livestock and Supply, Brazil) to verify whether the PBMPs mimic the traditional ones in their minimum and maximum limits established for each macronutrient. The label of twelve traditional meat products classified by the three leading supermarkets in Brazil as the best sellers were used as a reference for animal products.

## III. RESULTS AND DISCUSSION

### *Ingredients*

Soy, the most produced legume in Brazil, is the most used source of protein in Brazilian PBMP (64.5%), followed by pea (37.3%) and wheat (23.7%). Among the categories, hamburgers are the ones that most use soy as a source of protein. Wheat and corn are predominant sources of carbohydrates in plant-based kibbehs and breaded. Carbohydrates without denomination of origin (NDO) were also found in the products (25 products in total), conveying to the consumer a lack of clarity as to the origin of the ingredients. Canola, coconut, cotton, linseed, palm, soybean, sesame, and sunflower were the lipid ingredients (fat and oils) found in the PBMP. Of these, sunflower oil was the most used (19 products in total). Regarding the micronutrients naturally present in red meat, less than half of the PBMP were supplemented with iron and vitamin B12. The most common condiments and spices in Brazilian PBMP are salt, pepper, onion, and garlic. Beetroot and synthetic caramel IV were the main dyes found in these products. As a preservative, methylcellulose appears in more than half of PBMP with stabilizing function (87%).

### *Nutritional value*

Plant-based hamburgers showed great variation in protein content, and the carbohydrates were the nutrient that varied the most among plant products of this category. According to Brazilian legislation (TRIQ) for traditional hamburger, 75% and 85% of plant-based hamburgers do not meet the protein minimum (15%) and carbohydrate maximum (3%), respectively. For the plant-based kibbehs, all had a higher carbohydrate content than the traditional versions. For breaded, 33% of products did not meet the protein limits (minimum of 11%). Among the 5 hotdogs evaluated, 3 of them had carbohydrate content above the established (less than or equal to 7%). Unlike meat products, which are naturally sources of vitamin B12, only 3 of the 21 PBMAs supplemented with this vitamin reached the recommended daily intake for adults, considering a portion of 100 g (data not shown in tabular form).

**Table 1**. Minimum and maximum nutrient contents of Brazilian PBMPs, compared with mean of nutrient content of traditional meat and meat products.

| Category | Calories (kcal/100g) | Protein (%) | Total Fat (%) | Saturated Fat (%) | Total Carbohydrate (%) | Dietary Fiber (%) | Sodium (mg/100g) | Vitamin B12 (µm/100g) | Iron (mg/100g) |
|---|---|---|---|---|---|---|---|---|---|
| Hamburger | 97.5 - 449.3 (193.1) | 2.6 - 23.8 (15.0) | 0.0 - 17.9 (13.7) | 0.0 - 12.3 (6.8) | 1.4 - 59.7 (1.5) | 0.0 - 0.4 (0.9) | 211.3 - 875.0 (585.0) | 0.2 - 3.0 na | 0.3 - 11.7 na |
| Meatball | 99.0 - 237.3 (205.0) | 5.7 - 16.3 (13.8) | 1.3 - 15.0 (15.0) | 0.0 - 9.8 (7.2) | 4.3 - 44.0 (4.8) | 1.0 - 5.8 (0.9) | 222.5 - 803.0 (610.6) | 0.4 - 0.9 na | 2.6 - 2.9 na |
| Kibbeh | 99.0 - 237.3 (208.6) | 5.7 -16.3 (12.4) | 0.0 - 13.4 (14.5) | 0.0 - 6.1 (5.7) | 10.0 - 44.0 (7.6) | 3.3 - 4.8 (3.1) | 118.8 - 733.8 (635.4) | 0.9 - 0.9 na | 0.4 - 2.6 na |
| Meat/Chicken | 79.0 - 287.5 na | 12.4 - 23.1 na | 0.0 - 12.0 na | 0.0 - 9.4 na | 3.9 - 15.0 na | 0.0 - 10.0 na | 31.3 - 790.0 na | 3.0 - 3.0 na | 2.5 - 5.0 na |
| Breaded | 98.0 - 275.4 (145.0) | 6.0 - 17.5 (15.3) | 3.1 - 13.8 (9.5) | 0.3 - 6.5 (2.6) | 5.2 - 27.8 (11.3) | 1.0 - 12.2 (1.1) | 245.6 - 600.0 (525.0) | 0.2 - 1.4 na | 0.8 - 4.2 na |
| Sausage | 40.0 - 278.0 (208.6) | 11.4 -17.0 (14.7) | 2.0 - 19.0 (15.1) | 0.0 - 7.8 (4.8) | 3.8 - 17.0 (1.8) | 0.0 - 11.2 (0.0) | 571.4 - 1048.0 (955.0) | na na | na na |
| Hotdog | 66.0 - 194.0 (245.0) | 7.0 - 19.4 (12.8) | 4.8 - 13.4 (19.5) | 0.5 - 1.3 (8.5) | 4.5 - 16.8 (4.5) | 1.0 - 6.3 (0.0) | 140.0 - 682.0 (1110.0) | 0.8 - 1.4 na | 4.2 - 6.2 na |

na = not applicable/not informed. Number of plant-based products = 20 hamburgers, 10 meat/chicken, 6 meatballs, 6 kibbehs, 6 breaded, 6 sausages, and 5 hotdogs. Parentesis = mean of two top sellers traditional meat products in each category.

## IV. CONCLUSION

Our label analysis showed that Brazilian PMBPs should not be considered nutritionally equivalent to traditional products. If, on the one hand, some plant products have dietary fiber and vegetable oils rich in omega fatty acids, on the other hand, traditional meat products deliver higher quality protein, in addition to not needing supplementation of B-complex vitamins and iron. This study raised questions that should be considered in the elaboration of Brazilian legislation for these products.

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