USE OF PROTEIN AND NON-PROTEIN EXTENDERS IN BEEF BURGER: INFLUENCE ON TEXTURE PROPERTIES AND YIELD

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Abstract – Beef burgers were prepared using textured soy protein (TSP), collagen (CL) and maltodextrin (MD) as extenders to analyze their influence, added singly or in combination, on the chemical composition of cooked product, on the texture properties, on the cooking yield and reduction in diameter. In the cooked beef burger, there was a significant difference in the moisture, lipids and ash contents among the treatments. The treatment added by maltodextrin had the highest moisture content while the treatment added by textured soy protein and collagen had the lowest moisture. The treatment containing textured soy protein presented the highest lipid and ash contents. The treatment containing textured soy protein and maltodextrin showed the biggest cooking yield and lowest reduction in diameter. All the texture parameters were influenced significantly. The treatments containing textured soy protein and collagen presented the highest hardness and chewiness and the lowest cohesiveness and elasticity.

Keywords: Collagen, Maltodextrin, Textured Soy Protein.

I. INTRODUCTION

Beef burgers are an industrialized product made from minced meat, to which fat and other ingredients (vegetable fat, water, milk powder, sugar, animal and/or vegetable protein, maltodextrin, intentional additives, spices and flavoring) may be added, molded and subjected to a suitable technological process [1].

Textured soy protein has been used in meat products in order to increase water and protein contents, improve the sensorial characteristics such as texture and reduce the production cost due to the substitution of portion of the meat. [2]. Collagen, a fibrous protein responsible for structural support of many animal tissues, is used in several food products to improve the elasticity, consistency and stability [3]. In meat products, even in low quantities, collagen presents a stabilizing effect due to the ease with which it bind with water and it is compatible with meat protein [4].

Also considered as an extender for meat products, maltodextrin is a polysaccharide composed of D-glucose molecules. It is obtained by the partial hydrolysis of starch. Maltodextrin is classified according to its dextrose equivalent (DE) ranging from 3 to 20 or from almost sugarless to moderately sweet, this is because the higher the DE value, the shorter the glucose chains, making it sweeter and more soluble [5]. However, a longer glucose chain increases the binding affinity with water and it becomes a gel that has some similar characteristics to fat, enhancing the juiciness and tenderness of meat products. So it is widely used as a fat replacer [4].

The aim of this work was to analyze the effect of adding different protein extenders (textured soy protein and collagen) and non-protein extenders (maltodextrin) in beef burgers, evaluating the texture, cooking yield, reduction in diameter and the chemical composition.

II. MATERIALS AND METHODS

Eight types of beef burger were prepared. In all treatments 69% meat, 13% fat, 1.2% salt, 0.6%

Table 1 – Water and extenders quantities (%) of each treatment.

Ingredient	CT	T1	T2	T3	T4	T5	T6	T7
Water	15	13	14	14	12	12	13	11
TSP	0	2	0	0	2	2	0	2
CL	0	0	1	0	1	0	1	1
MD	0	0	0	1	0	1	1	1

TSP: textured soy protein; CL: collagen; MD: maltodextrin; CT: control treatment; T1: treatment with TSP added; T2: treatment with CL added; T3: Treatment with MD added; T4: treatment with TSP and CL added; T5: treatment with TSP and MD added; T6: treatment with CL and MD added; T7: treatment with all extenders.

burger seasoning, 0.4% sodium tripolyphosphate, 0.75% monosodium glutamate and 0.05% sodium erythorbate were used in the total formulation. The quantities of water, textured soy protein, collagen and maltodextrin quantities of each treatment are shown in Table 1.

The ingredients were weighed and mixed manually. Portions of 70 g were formatted to obtain the burger samples, and then were frozen at -18 °C until use. For cooking, the samples were placed in baking trays covered with aluminum foil and taken to an industrial oven at 150 °C for 15 minutes, to ensure that the center of the samples reached the minimum temperature of 74 °C.

The treatments were chemically characterized in triplicate for moisture, protein, and ash content according to AOAC [6], the fat content was determined according to the Bligh & Dyer method [7] (the carbohydrate content was calculated by difference). The texture profile analysis (TPA) was realized in a TA-XT/PLUS/50 Texture Analyzer (Stable Micro Systems, Haslemere, Surrey, England) and evaluated according to the following parameters: hardness (the force necessary to attain a given deformation); cohesiveness (the strength of the internal bonds making up the body of sample); elasticity (the rate at which a deformed sample goes back to its undeformed condition after the deforming force is removed); and chewiness (energy required to chew a solid sample to a steady state of swallowing).

The cooking yield and diameter reduction analysis were performed on 10 samples of each treatment with measures before and after cooking.

The means were compared using the nonparametric ANOVA and Dunn's test, and the differences were considered significant at $p \leq 0.05$. Pearson correlation analysis among the variables was performed and considered strong correlation when the Pearson correlation coefficient was above 0.7 or below -0.7 ($p \leq 0.05$).

III. RESULTS AND DISCUSSION

The protein content was not significantly different ($p > 0.05$) for the treatments (Table 2). T3 had moisture content higher than T4. The DE of maltodextrin used is lower than 5, which means it has similar structural characteristics to a starch which, upon heating during preparation, forms a gel providing good water retention.

Table 2 – Chemical composition of beef burger (mean ± standard deviation).

Treatment	Moisture	Protein	Lipid	Ash	Carbohydrate
CT	57.5 ± 0.4^{ab}	17.2 ± 2.2^{a}	18.1 ± 0.0^{a}	3.8 ± 0.0^{ab}	3.5 ± 2.6
T1	56.7 ± 1.1^{ab}	18.6 ± 1.2^{a}	18.6 ± 0.5^{a}	4.1 ± 0.0^{a}	2.0 ± 2.8
T2	57.5 ± 0.1^{ab}	20.1 ± 0.5^{a}	$17.2 \pm 0{,}3^{ab}$	3.7 ± 0.0^{b}	1.5 ± 0.9
T3	59.9 ± 0.1^{a}	17.9 ± 1.1^{a}	16.7 ± 0.5^{ab}	4.0 ± 0.2^{ab}	1.5 ± 1.9
T4	55.2 ± 0.3^{b}	22.4 ± 0.5^{a}	17.5 ± 0.3^{ab}	3.9 ± 0.2^{ab}	1.0 ± 1.3
T5	57.6 ± 0.2^{ab}	18.8 ± 0.4^{a}	16.8 ± 0.4^{ab}	3.8 ± 0.0^{ab}	3.0 ± 1.0
T6	57.0 ± 0.3^{ab}	19.9 ± 0.8^{a}	17.2 ± 0.5^{ab}	4.0 ± 0.0^{ab}	1.9 ± 1.6
T7	56.6 ± 0.2^{ab}	21.2 ± 0.8^{a}	14.9 ± 0.0^{ab}	4.1 ± 0.0^{ab}	3.2 ± 1.0

Legend as Table 1.
Different letters (a and b) in the same column indicate significantly different means ($p \leq 0.05$).

Table 3 – Texture Profile Analysis of beef burger (mean ± standard deviation).

Treatment	Hardness (N)	Cohesiveness	Elasticity	Chewiness (N)
CT	15.38 ± 3.34^{b}	0.69 ± 0.02^{a}	0.78 ± 0.04^{ab}	8.23 ± 1.83^{a}
T1	20.55 ± 4.18^{ab}	0.64 ± 0.31^{b}	0.74 ± 0.06^{b}	9.82 ± 2.41^{a}
T2	22.06 ± 3.58^{a}	0.64 ± 0.42^{b}	0.77 ± 0.04^{ab}	10.67 ± 1.26^{a}
T3	17.06 ± 3.83^{ab}	0.64 ± 0.03^{b}	0.77 ± 0.05^{ab}	8.38 ± 1.90^{a}
T4	21.38 ± 3.49^{a}	0.64 ± 0.02^{b}	0.75 ± 0.04^{b}	10.37 ± 1.93^{a}
T5	19.93 ± 3.23^{ab}	0.67 ± 0.02^{ab}	0.81 ± 0.04^{ab}	10.64 ± 1.67^{a}
T6	17.71 ± 3.38^{ab}	0.67 ± 0.02^{ab}	0.79 ± 0.02^{ab}	9.36 ± 1.59^{a}
T7	19.70 ± 2.37^{ab}	0.67 ± 0.03^{ab}	0.83 ± 0.03^{a}	10.86 ± 1.59^{a}

Legend as Table 1.
Different letters (a and b) in the same column indicate significantly different means ($p \leq 0.05$).

On the other hand, T3 showed the lowest moisture content because part of the protein content may have been denatured, resulting in a drip loss. The ash content of T1 was higher than T2. This difference can be assigned to the chemical composition of TSP which may contain up to 7% of ash while the collagen generally contains 2%.

According to Brazilian law [1], the chemical composition presented by the samples is within the established standards. In De Borba *et al.* [8] study, obtained similar values to those of this work when analyzing the chemical composition of beef burgers.

In relation to hardness (Table 3), although this work did not show a correlation with the moisture content, it did show that the treatments using protein extenders (T2 and T4) were harder (22.06 N and 21.38 N, respectively) than the control (15.38 N).

Table 4 – Diameter reduction and cooking yield of beef burger (mean ± standard deviation).

Treatment	Reduction in Diameter (%)	Cooking Yield (%)
CT	28.7 ± 3.3^{ab}	74.0 ± 3.4^{ab}
T1	28.4 ± 2.4^{ab}	75.7 ± 4.7^{ab}
T2	30.8 ± 3.0^{a}	73.1 ± 3.0^{b}
T3	26.8 ± 4.4^{ab}	79.1 ± 5.1^{a}
T4	30.3 ± 2.4^{a}	71.0 ± 3.3^{b}
T5	26.8 ± 2.4^{b}	80.1 ± 2.8^{a}
T6	30.3 ± 4.2^{a}	73.9 ± 4.3^{ab}
T7	28.4 ± 2.5^{ab}	75.6 ± 3.1^{ab}

Legend as Table 1.
Different letters (a and b) in the same column indicate significantly different means ($p \leq 0,05$).

According to Brewer [5], water is first maintained within the cells by contractile proteins and, for this reason, an increase in temperature or a reduction in pH causes a larger cooking and a consequent drip loss.

Cohesiveness was lower for the treatments which used the extenders singly (T1, T2 and T3) or with two protein extenders combined (T4) when compared to control treatment (CT), so there is a tendency for the structure be more cohesive when the maltodextrin is combined with one or both of the other extenders. Elasticity was higher in T7 compared with T4, which shows influence of maltodextrin on this characteristic of the product. Moreover, chewiness showed a strong positive correlation ($p = 0.000$) with the hardness. Chewiness was not significantly different ($p > 0.05$) for the treatments.

The reduction in diameter (Table 4) of T5 was not different ($p > 0.05$) from the control treatment (CT); however it was less when compared with treatments that used collagen singly (T2) or combined with TSP (T4) and MD (T6).

In their study, De Borba *et al.* [8], evaluated different thermal treatments in preparing commercial beef burgers and found a reduction in diameter of 16.87% that is lower than the CT of this work (28.7%). This result may be related with to production process and the ingredients used.

The treatments with collagen used singly (T2) or combined with TSP (T4) showed a lower cooking yield when compared to the treatment with TSP and MD (T5). Furthermore, a strong negative correlation (p = 0.001) was verified between the diameter reduction and the cooking yield.

IV. CONCLUSIONS

Maltodextrin used singly (T3) as an extender in beef burger provided higher moisture content and higher cooking yield. Collagen (T2) and collagen with TSP (T4) as extenders affected the beef burgers giving higher levels of hardness and lower moisture content, cohesiveness and elasticity and cooking yields.

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