COOKING SHRINKAGE IN PLANT-BASED AND MEAT PATTIES

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I. INTRODUCTION

When assessing meat, consumers typically consider three pivotal moments: the initial purchase, where factors like appearance and color hold significant sway; the cooking process, during which shrinkage and loss of juices are scrutinized; and finally, consumption, where tenderness, juiciness, and aroma reign supreme. These parameters are intricately linked, with a discernible correlation between shrinkage and juiciness [1]. The perception of meat shrinkage during cooking is often equated with inferior quality [2], however, when examining plant-based products, such as patties, shrinkage is less conspicuous [3]. Plant-based meat analogue foods are meticulously crafted to replicate the characteristics of their animal-based counterparts, including patties, sausages, and nuggets but in plant-based products. This study endeavors to compare the shrinkage observed in cooked meat patties with plant-based meat analogue patties.

II. MATERIALS AND METHODS

A total of 146 patties were utilized, divided into eight distinct types. These consisted of six homemade types (HB, 64 patties divided between the 6 groups), one commercial type (CB, 30), one commercial precooked (PB, 22) pea protein-based type of patty, and one homemade meat patty (MB, 30) blending 60% beef and 40% pork. The 6 HB types were crafted by combining various proportions of commercial pea protein products, and diverse preparation methods and recipes. Evaluation of the patties took place post-cooking. Cooking shrinkage was gauged using a 1 cm thick disc, employing the methodology outlined by Barbera and Tassone [4], expressed as a percentage of the raw area. Other parameters were measured following the protocol outlined by Mabrouki et al. [5] such as: total moisture content measured on frozen sample as percentage of the raw weight (RW); fluid and protein content in the cooked sample, expressed as a percentage RW. Additionally, four Texture Profile Analysis parameters - hardness, gumminess, chewiness, and adhesiveness - were assessed on each homogenized cooked sample [5]. The specific density of the homogenized cooked sample was also determined. Statistical analyses, including Variance and Canonical Discriminant Analysis (CDA), were conducted using SAS 9.4 and Rstudio to compare the MB, CB, PB types and HB group. To facilitate comparisons, the 6 HB types have been consolidated into a single group.

RESULTS AND DISCUSSION

Table 1 presents the average values of the parameters examined across different patty types. It was observed that the MB exhibited the most substantial shrinkage, while both the CB and HB demonstrated comparable rates of shrinkage, and the PB exhibited the least. Remarkably, although the MB and PB boasted the highest protein content, and the HB had the lowest, the latter paradoxically displayed a higher fluid-to-mouth value. This observation suggests that veggie patties may indeed be juicier than their meat counterparts. However, an analysis of density reveals that the MP has a significantly higher value compared to the plant-based patties, indicating a higher liquid content. This disparity stems from the distinct protein sources - animal *versus* vegetable. Animal proteins tend to form a more robust lattice structure that effectively retains liquids, a characteristic not typically seen with plant proteins. Further measurements using Texture Profile Analysis (TPA) confirm these differing behaviors, with the meat patty exhibiting greater hardness even surpassing that of the pre-cooked PB patty. This distinct response of the meat patty compared to plant-based alternatives aligns with findings from other studies [6,7], albeit with varying numerical values due to differences in methodology. The meat patty experiences more significant shrinkage and presents as harder and chewier compared to plant-based counterparts. Moreover, when considering MB fluid to mouth value on a raw weight, there

Table 1 – Average values measured on cooked samples, except total moisture on frozen one (n = 146).

Traits		Type of patty				MSE
		MB	CB	HB	PB	
Cooking shrinkage	%	24.2^{A}	11.7^{B}	11.0^{B}	$7{,}1^{C}$	4.433
Total moisture	% WB	63.7^{A}	60.3^{B}	59.9^{B}	54.4^{C}	6.592
Fluid to the mouth	% WB	43.7^{B}	46.3^{A}	46.7^{A}	46.0^{A}	5.241
Density	mg/mm^3	1.36^{A}	1.00^{C}	1.03^{C}	1.10^{B}	0.0051
Crude Protein	% WB	20.8^{B}	18.6^{C}	15.9^{D}	23.1^{A}	3.223
Hardness	N	28.6^{aA}	5.6^{C}	10.1^{B}	25.1^{bA}	9.975
Gumminess	N	13.9^{A}	2.3^{D}	5.7^{C}	10.2^{B}	4.265
Chewiness	N	10.9^{A}	2.1^{D}	5.1^{C}	8.3^{B}	2.298
Adhesiveness	10^{-3} J	-8.2^{C}	3.0^{B}	7.7^{A}	-9.0^{C}	0.023

MB = meat patty; CB = commercial plant-based patty; HB = homemade plant-based patties; PB = precooked commercial plant-based patty, RW = raw weight. $^{a, b}$ P = 0.05, $^{A, B, C, D}$ P =< 0.01: based on Tukey's test on the same row.

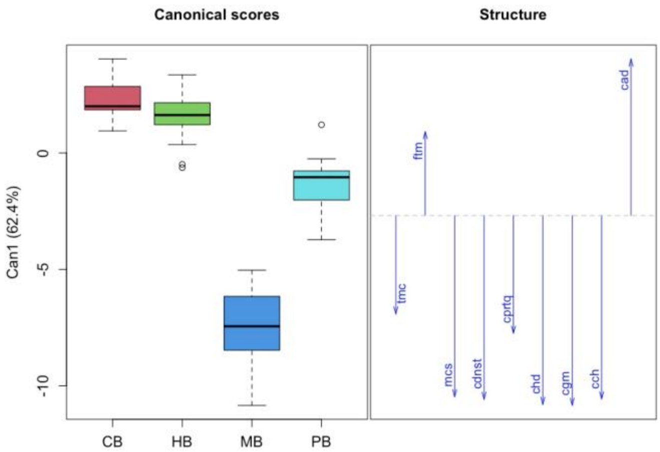

Figure 1. Canonical Discriminant Analysis and contribution of parameters, according to the Total Canonical Structure, to separate the different types of patties. CB commercial, HB homemade, MB meat and PB pre-cooked patties. Tmc - total moisture content; ftm - fluid to the mouth; mcs – cooking shrinkage; cprtq - raw protein; chd – hardness; cgm – gumminess; cch - chewiness; cad – adhesiveness; cdns – density.

appears to be a higher quantity of water within a smaller volume, as indicated by the density measurements. This aspect has been overlooked in prior literature.

Figure 1 provides a visual summary of a CDA, highlighting the contribution of various parameters in identifying distinct patty groups, notably showcasing the meat patty's divergence from the others.

CONCLUSION

Our study highlights the crucial role of cooking shrinkage in shaping vegetable patties to closely mimic the texture and protein attitude of their meat counterparts.

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