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REDUCED-FAT HYBRID BEEF BURGERS WITH ADDED EMULSION GEL

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I. INTRODUCTION

Hybrid meat products combine plant-based ingredients with traditional meat and aim to balance reduced meat or fat content while maintaining desirable sensory, nutritional and textural attributes [1]. A critical challenge in such formulations is replicating animal fat's functional and sensory roles, an essential component in conventional meat products [2]. This study focused on the replacement of beef fat with a faba bean protein isolate (FBI)-stabilized canola oil-in-water emulsion gel in hybrid beef burger formulations, presenting a novel approach to achieving sustainability without compromising quality. Specific objectives included evaluating the impact of the emulsion gel on the sensory, textural and nutritional attributes of hybrid beef burgers and assessing the stability and performance of canola oil-in-water emulsion gels in burgers under typical meat storage conditions.

II. MATERIALS AND METHODS

The emulsion gel was prepared from pretreated FBI, water, and canola oil using a microfluidizer (103.4 MPa, Microfluidics Corp.). After that, 2% sodium chloride was added, and a final heat treatment was applied before it was frozen and stored at -30°C. The finished emulsion gel was composed of 30% canola oil, 59.6% water, 8.4% FBI, and 2% salt. Beef eye of round (*semitendinosus* muscle, Grade AAA, 14 days postmortem) and beef fat were ground (12.7 mm), vacuum packed and frozen at -30°C until needed. Four formulations were prepared: Full-fat beef burgers (20% fat), low-fat beef burgers (10% fat), low-fat hybrid burgers with half-fat replacement with the emulsion gel and low-fat hybrid burgers with full-fat replacement with the emulsion gel. All formulations contained 73% lean beef, 1% salt and 0.25% spices. For the full-fat beef burger formulation, 20% beef fat and 5.8% ice water were added. For the low-fat beef burger, beef fat was reduced to 8.7%, and water increased to 17.2 %. The half-fat hybrid had 5% beef fat, 0.4% water and 20.1% gel, while the full-fat replacement hybrid utilized 26.5% gel alone. Thawed meat, fat and gel were ground (4.8 mm), mixed with other ingredients and reground. Meat mixtures were formed into 12 cm burgers (120 g each) using a patty former and then frozen and stored at -30°C for further analysis. Cooking was done on a 180°C electric griddle, with burgers flipped every 2 min until the internal temperature reached 71°C.

Raw and cooked burgers were analyzed for moisture, fat, protein and ash contents using AOAC 2000 methods. Fatty acid composition was analyzed by fatty acid methyl ester (FAME) gas chromatography using a Perkin-Elmer gas chromatograph (model Clarus 500, Shelton, MA, USA). Assessment of burger cooking properties included cook yield, diameter shrinkage and thickness changes. Compression juiciness, Warner Bratzler shear values and texture profile analysis (TPA) parameters were measured using a TMS-Pro Texture Press. A HunterLab Colorflex colorimeter using illuminant A and 10° observer was used to measure CIE colour. The raw burgers were assessed for oxidative stability by determining the evolution of the thiobarbituric acid reactive substances (TBARS) content during 2 months of frozen storage at -20°C. Sensory evaluation was also performed. After receiving ethical approval from the University of Saskatchewan (BEH4092), sixty consumers from the university community evaluated the burgers on a number of attributes using nine-point hedonic scales. Three full replications of the study were completed. Analysis of variance and means separation (Duncan Multiple Range test) was performed using SPSS version 21 software.

III. RESULTS AND DISCUSSION

Replacing beef fat with the FBI-stabilized canola oil emulsion gel increased the protein content of the raw hybrid burgers by about 1.5% (data not shown) and pH by 0.10 units (Table 1). Cooking yield increased with replacement of the beef fat with the emulsion gel, reflecting the high water holding capacity of the FBI-stabilized emulsion gel. TPA hardness and chewiness increased, but no significant difference was observed in other TPA properties (data not shown). Replacing beef fat with the emulsion gel increased the L* (lightness) of the raw burgers, with no significant differences in colour of the cooked burgers. Saturated fatty acid (SFA) content was reduced in raw (by 13-35 %) and cooked (by 35-66%) half and full canola gel hybrid burgers compared to that of the low-fat control, while polyunsaturated fatty acid (PUFA) content increased significantly (by 78-87% and 76-85%, respectively). Monounsaturated fatty acid (MUFA) content also increased. Figure 1 shows the increase in malondialdehyde (MDA), the oxidative degradation product of unsaturated fatty acids, over a storage period of two (2) months. The lowest amount of MDA over the storage period was found for the hybrid samples, especially with full replacement of beef fat by the canola oil emulsion gel. It is possible that the FBI in the continuous phase of the emulsion gel was sufficient to create a thick film at the oil droplet interphase, hence protecting the oil droplets from

lipid oxidation during frozen storage. Also, FBI may have an antioxidant role. Consumer sensory evaluation showed that all the formulated burgers were acceptable, with no significant differences in the degree of liking of cooked appearance, cooked surface colour, and juiciness. Mouthfeel of the beef-fat/canola gel hybrid beef burgers was liked significantly more than the full-fat control. In addition, panelists indicated a high degree of liking for the overall acceptability of the hybrid beef burgers (a score of 7.2 to 7.3 on the 9-point hedonic scale), similar to that of the control beef burgers.

Table 1. Selected properties of the beef and hybrid burgers

Sample	Full-fat	Low-fat	Beef-fat/canola gel hybrid	Canola gel-hybrid
pH, raw	5.7±0.06^{ab}	5.6±0.05^{a}	5.8±0.10^{c}	5.7±0.08^{bc}
Cook loss (%)	33.6±3.53^{a}	33.2±3.76^{a}	28.4±3.91^{ab}	21.4±1.59^{b}
Hardness (N)	43.7±3.03^{bc}	36.4±2.96^{c}	53.7±3.33^{a}	50.2±6.83^{ab}
Lightness, raw (L*)	55.7±3.95^{bc}	52.3±4.75^{c}	62.6±3.33^{a}	65.3±4.14^{a}
Lightness, cooked (L*)	41.8±1.71^{a}	43.2±1.48^{a}	37.0±1.86^{b}	44.8±3.42^{a}
Redness, cooked (a*)	14.4±0.17^{a}	13.3±0.77^{a}	14.6±1.07^{a}	13.8±1.31^{a}
Yellowness, cooked (b*)	25.2±0.63^{a}	22.9±1.63^{b}	26.2±0.65^{a}	25.2±1.61^{a}
Mouthfeel[1]	6.6±1.37^{a}	6.9^{ab}±1.37^{ab}	7.2^{b}±1.05^{b}	6.8±1.34^{ab}
Overall acceptability[1]	6.9±0.97^{a}	7.2±1.32^{a}	7.3±0.89^{a}	7.2±1.21^{a}

[1]Nine point hedonic scales with 1=dislike extremely and 9=like extremely, 60 consumers

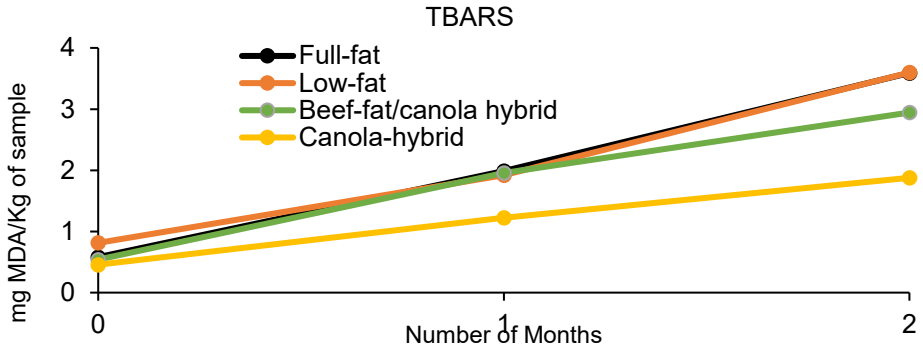


Figure 1. Effect of replacement with faba bean isolate stabilized canola oil-in-water emulsion gels on oxidative stability of raw burgers stored at -20°C.

IV. CONCLUSION

In conclusion, the replacement of beef fat with faba bean protein isolate-stabilized canola oil-in-water emulsion gel improved the cook yield and reduced shrinkage. The TPA hardness increased with emulsion gel inclusion in the burgers. Raw hybrid burgers were much lighter in colour than controls, but showed mimimal differences after cooking. The fatty acid profile of the hybrid burgers was improved; the SFA decreased while the PUFA and MUFA increased with emulsion gel inclusion. All the burgers were acceptable to the consumer panel. Emulsion gel inclusion also lowered the TBARS in the hybrid burgers during storage. This study critically addresses consumer demands for healthier, more sustainable, and plant-enriched food options, contributing to the broader goals of reducing the environmental impact of food production and promoting public health.

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