

Project Summary

Blended Lipid Solutions as a Functional Ingredient to Enhance the Nutritional Value of Ground Beef

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Background

Consumer perceptions about beef's nutritional profile have been one factor that potentially affects demand. In order to be consumer driven, there is a desire by the beef industry to provide more low-fat products. However, the development of low-fat ground beef products that possess acceptable palatability is a complex process that requires careful consideration of the impact of fat reduction or replacement on sensory, textural and shelf-life attributes. Fat is a calorie-dense nutrient that provides, flavor, juiciness, texture and aids in entrapping water in ground meat products. Attempts to reduce fat content too much in beef products may lead to meat that is less desirable to consumers.

Previous research has attempted to incorporate fat replacements into ground products to increase the percentage of desirable oleic and linoleic acids, however issues arose with fat retention and sensory attributes. The current experiments investigated using a single source of fat or oil as a replacement.

The researchers conducting this project hypothesized that a blend of beef tallow (57 percent) and safflower oil (43 percent) might be a better alternative to enhance the nutritional value without sacrificing quality and consumer eating experiences.

The specific objectives of this study were:

1. Develop various lipid solution blends that are similar to fat in appearance and functionality yet containing a more desirable fatty acid profile;
2. Develop a processing system to incorporate the "modified lipid" solutions into a ground beef patty system;
3. Compare the sensory, physico-chemical and shelf-life of ground beef patties manufactured with the "modified lipid" solution to a control treatment.

Methodology

Lipid blends were manufactured by weighing out portions of beef tallow and either a high oleic safflower oil, olive oil or corn oil to achieve 57 percent beef tallow/43 percent edible oil mixture. Rosemary extract was added at 0.3 percent directly to the oils to act as an antioxidant. Lean ground beef was produced from inside rounds (IMPS/NAMP 169A) and fat ground beef was fabricated from beef plates (IMPS/NAMP 121). The ground inside rounds and beef plates were mixed separately in a paddle mixer and samples were taken to be analyzed for fat content and lipid oxidation prior to patty formulation.

Control patties were formulated to either 10 percent or 20 percent fat content. The experimental patties were formulated by adding the high oleic safflower, olive oil or corn oil lipid blends (97 percent fat) to the lean beef (6 percent fat) to obtain a final fat percentage of either 10 or 20 percent.

The patties were analyzed for refrigerated retail and frozen beef patty shelf life. Four overwrapped trays representing each treatment group were stored in a cooler under fluorescent lights for either three, six or nine days before being analyzed. Each sample was analyzed for objective color, lipid

oxidation and pH. Cooked beef patties' internal surfaces were also analyzed for objective color measurements and pH.

The researchers also analyzed each lipid blend formulation for objective color measurements prior to being incorporated in the beef patties.

Raw (refrigerated zero, three, six and nine days) and frozen (frozen zero, seven, 14, 28, 42 and 56 days) patties and cooked beef patties (prepared after 28 days of frozen storage) were analyzed for lipid oxidation rates.

A trained sensory panel was used to evaluate cooked beef patties for flavor, mouth feel, basic taste, aftertaste and texture. All samples were scored using a 15-point intensity scale where 0 meant an attribute was absent and 15 meant that an attribute was extremely intense. The panelists evaluated 24 samples at a rate of eight samples per day for three days.

Findings

Both the 10 percent and 20 percent control patties were lower in fat percentage than the other treatments. The 20 percent fat control patties were higher for cooked fat percentage than the other 20 percent treatment patties. The researchers hypothesized that this was due to higher melting point of saturated fatty acids, which were more abundant in the control patties.

Oxidation rates as measured by thiobarbituric acid test (TBA) for both refrigerated and frozen patties showed some limited differences between treatments. At day three of refrigerated storage, the control patties (20 percent fat) had a lower TBA value than all other treatments and the researchers hypothesized it was due to their higher fat content and the absence of the rosemary extract present in the treatment patties. The control patties (20 percent fat) was the only treatment at day three to have a TBA value of less than one, which is considered to be the value at which a product becomes rancid. All treatments had become rancid at day six. During the 56 days of testing during frozen storage, none of the treatments reached a TBA value of one, which is the point at which a product is considered rancid. Overall, no treatment patties were higher than the controls for lipid oxidation at any day during the study.

Color differences between the treatments were also limited. During refrigerated storage, none of the treatments were higher than the control patties for redness, however all of the 20 percent treatment groups (olive oil, safflower oil, corn oil) were lower in redness values than the 20 percent control.

The pH of the treated patties did not show any significant differences between days zero and 56.

Results from the trained sensory panel indicated that the oil treatment used in the ground beef patties had an effect on sensory texture, but no effect on aromatics, basic tastes, mouthfeel or after mouthfeel. Beef patties manufactured with safflower oil at the 20 percent level had the highest ratings for juiciness and were significantly higher than the control (10 percent fat) and the olive oil (10 percent fat) patties.

Overall, the 10 percent patties tended to be less juicy than the 20 percent fat patties. Aromatics associated with warmed over flavor (WOF), such as "cardboard," "painty," and "fishy" were only slightly detected and were not affected by treatment. No attributes associated with warmed over flavor were above 0.67 on a 15-point scale.

Percentage cook yield was higher for patties containing 10 percent fat than those containing 20 percent fat. That result mirrors past research that demonstrated that beef patties with lower fat percentages tend to have higher cook yields. The controls had the highest cook yields within each of the fat levels (10 percent and 20 percent).

All of the 20 percent fat treatments were lower for Allo-Kramer shear values, and thus more tender, than the corresponding 10 percent fat patties for each oil treatment. Overall, all of the experimental treatments were as tender or more tender than the control patties.

Of critical importance to the objective of this research project was to improve the nutritional profile of the ground beef patties by replacing natural beef fat with a lipid blend. The table below summarizes least square means for fatty acid composition of the various treatments.

Table 1. Least square means for fatty acid composition of fat blends formulated with beef tallow (57 percent) and mono- or polyunsaturated oils (43 percent).

Fatty Acid	High Oleic Safflower Oil	Olive Oil	Corn Oil	SEM ^d
Myristic 14:0	1.27	1.21	1.23	0.02
Palmitic 16:0	14.81 ^c	18.23 ^a	17.38 ^b	0.10
Palmitoleic 16:1	1.35 ^b	1.76 ^a	1.36 ^b	0.01
Stearic 18:0	10.27 ^b	11.36 ^a	10.35 ^b	0.10
Oleic 18:1	57.01 ^a	55.48 ^b	37.15 ^c	0.24
Linoleic 18:2	8.05 ^b	5.65 ^c	25.45 ^a	0.13
Linolenic 18:3	0.16 ^a	0.00 ^c	0.12 ^{ab}	0.04
UFA:SFA Ratio ^e	2.39 ^a	1.98 ^c	2.13 ^b	0.03
PUFA:SFA Ratio	0.30 ^b	0.17 ^c	0.83 ^a	0.01

^{abc} Means in a row with different superscripts are significantly different ($P < 0.05$)

^d SEM = Standard error of the mean

^e UFA:SFA = Unsaturated fatty acid to saturated fatty acid ratio

^f PUFA:SFA = Polyunsaturated fatty acid to saturated fatty acid ratio

All treatments were higher than the controls for unsaturated fatty acid (UFA) to saturated fatty acid (SFA) ratio content, although the 20 percent safflower oil and olive oil treatments were higher than the 10 percent treatments in oleic acid due to the higher percentage of beef fat from the raw materials.

The incorporation of specially formulated lipid blends with enhanced fatty acid profiles into beef patties resulted in a product that exhibited similar sensory traits and a healthier fatty acid profile compared to control beef patties.

Implications

Based on the results of this project, the addition of a beef tallow/edible oil lipid blend into a ground beef patty is feasible and will produce patties with similar physical and textural characteristics as those of a traditional beef patty, but with more desirable fatty acid content. This project demonstrated that commercial production of these nutritionally enhanced beef patties is possible.

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