WHEY AS AN ADJUNCT FOR RESTRUCTURED HAM

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INTRODUCTION

Whey, an opaque, greenish-yellow liquid, is released as a by-product of cheese manufacture. Approximately 46 billion pounds of whey is generated each year of which 24% of this by-product is further processed into various whey items (Anon., 1993). The remaining quantity is dumped or treated as waste material. This by-product is a foodstuff with nutritional value since it contains more than one-half of the solids present in the original whole milk.

Traditionally, whey has been considered to be a waste product that should be disposed of by the most economical method. A major challenge of disposal of this by-product exists because of the volume generated and environmentalists concern about pollution of streams. Thus, improvements in whey utilization or disposal are needed.

Recent developments in processing technology have permitted whey to become a versatile by-product of the food industry. Applied technology has included drying and evaporation techniques, membrane processing (such as ultrafiltration and reverse osmosis), and demineralization by ion exchange and electrodialysis. These techniques modify the composition of whey and permit the extraction of proteins and minerals.

Utilization of dried and processed whey as a foodstuff or adjunct for other foods including the addition to processed meats has been studied. Hung and Zayas (1991) reported that frankfurters extended with milk proteins exhibited acceptable stability. The suitability of whey is affected by the cost of drying or other processing methods. Because the potential value of liquid whey to fortify low-fat products and improve functionality has not been elucidated, this study was conducted.

MATERIALS AND METHODS

Sample Preparation:

Boneless pork hams (including the knuckle) were trimmed of fat and passed once through a kidney shaped grinder plate in a Hobart grinder (Model 4532, The Hobart Manufacturing Company, Troy, Ohio) to reduce particle size. The products were formulated with 34% (of meat base) of commercial cure adjuncts, water, and liquid whey. The added levels of whey were 20% and 30% for treated samples and no whey was added to the controls. The materials were mixed (massaged) 30 min with curing adjuncts, seasoning, and water or whey in a Hobart mixer (Model A-200, The Hobart Manufacturing Company, Troy, Ohio). After storage at 1-2°C for overnight, the materials were stuffed into 8.0 cm casings and cooked and smoked in an electronic operated smokehouse to an internal temperature of 70°C. The products were sliced, vacuum packaged, and stored at 1-2°C for further evaluation.

Cooked-Chilled Yield and Proximate Analysis:

The percentage of cooked-chilled yield of ham samples was determined as the weight of the cooked product after chilling divided by the weight of the uncooked products and multiplied by 100. Moisture, fat, and protein of products were determined in duplicate by AOAC (1990) methods.

Sensory Evaluation:

Sensory evaluations of products were conducted after production (0 days) and storage for 14 and 28 days. Juiciness, tenderness, and off flavor of samples were evaluated by eight trained (Rainey, 1979) panelists using an 8-point scale (1=very dry, 8=very juicy for juiciness; 1=very tough, 8=very tender for tenderness; 1=abundant, 8=none for off flavor).

Visual Evaluation and CIE L* a* b* Determination:

After production (0 days) and 14 and 28 days of storage, discoloration and intact muscle cut resemblance of samples were evaluated by 8 trained (Rainey, 1979) panelists using an 8-point scale (1=very abundant, 8=none for discoloration; 1=very lacking of similarity, 8=very similar for intact muscle cut resemblance) under 1350 lux of Examolite Light (Model TC-440, Macbeth Corporation, Newburgh, N.Y.) which was devised to simulate the north sky daylight at 7400 °K.

CIE L* a* b* values were determined at 0, 14, and 28 days after production using a chroma meter (model CR-200, Minolta Camera Co., Ltd., Osaka, Japan). The meter was calibrated using a standard Minolta calibration plate (CIE L* = 97.91, a* = 0.70, b* = +2.44). CIE L* a* b* values for each treatment were determined by averaging five repeated readings from the cut surface of sample slices.

Storage Loss Determination:

One slice of product from each treatment was weighed and vacuum packaged (17 kPa, Model VC999/01, Inauen Maschinen AG, Herisau, Switzerland) into bags (type B540, Cryovac Division W.R. Grace & Co., Duncan, S.C.). The packages were stored at 1-2°C. After 14 and 28 days of storage, the samples were removed from the packages, patted dry with paper towels and weighed. Storage loss was calculated as the percentage weight loss of the products after storage.

Instrumental Texture Analysis:

The texture of products was characterized using an Instron (Model 1011, Instron Corp., Canton, Mass.) following the general procedures of Bourne (1978). The hardness (kg) of the samples were determined by the maximum peak force during a single compression to 25% of the original sample height.

Standard Plate Count:

The microbial stability of products during storage was determined at 0, 14, and 28 days by the Standard Plate Count (SPC) method. Eleven grams of a sample with 99 mL of 0.1% peptone solution were homogenized for 2 min in a stomacher (Model S1-10-400, Techmar Co., Cincinnati, Ohio) and the subsequent solution was used for SPC. The plates were incubated at 35°C for 48 hrs.

Statistical Analysis:

Data were analyzed using the General Linear Model (GLM) procedure for SAS (1989) as a split-plot randomized block design (3 whey levels and 3 storage times) to determine if there were significant whey level by storage time interactions. When no significant interactions were determined, the effects of whey levels were determined separately by storage time as a randomized complete block design having 3 whey levels and 3 replications. When significance ($P<0.05$) was determined for treatment, means were separated using the Least Significant Difference test (SAS 1989).

RESULTS AND DISCUSSION

Sensory and Visual Traits:

The addition of 20% or 30% liquid whey to the cure formulation for low-fat (3.9-4.5%) ham as a substitute for water had no effect ($P>0.05$) on juiciness, tenderness, and flavor and visual discoloration as evaluated by the trained sensory panel. None of these scores differed ($P>0.05$) from the control samples that contained water in the cure formulation instead of liquid whey (0% whey). In fact, no differences ($P>0.05$) in these traits were observed among the samples with 0, 20, and 30% liquid whey among the evaluation periods conducted at 1, 14, and 28 days.

After 14 days of storage, the cured product with 20% liquid whey received higher ($P<0.05$) muscle cut resemblance scores than the samples with 0 or 30% liquid whey. The most obvious explanation for this variation is attributable to experimental variation. This difference should not be considered as too important since it is only approximately 0.5 on an 8-point evaluation scale. Furthermore, when the storage periods were combined, liquid whey addition had no effect ($P>0.05$) on muscle cut resemblance.

The objective evaluations of product acceptability such as CIE L* a* b* values, peak force, cooking loss, weight loss during storage, microbial load, percentage protein, and percentage fat revealed that samples with 20% and 30% liquid whey were not different ($P>0.05$) from those without the addition of this adjunct. Low-fat ham samples fortified with 30% whey contained less ($P<0.05$) moisture than the control samples, even though the product with 20% liquid whey did not differ ($P>0.05$) in percentage moisture from the 30% or control treatments. Because of the high water content of whey, this observation is attributable to experimental variation.

Sensory scores revealed that all products exhibited very satisfactory evaluations for juiciness, tenderness, and flavor. Although the potential existed for products with 20% and 30% fat liquid whey to exhibit an off flavor, the trained panelists did not detect such an effect. Visual scores CIE L* a* b* values and the low levels of microbial flora suggest that the samples exhibited stability for these traits throughout the study without liquid whey contributing to the deterioration of appearance traits or microbial flora proliferation. Although the cooking loss and weight loss during storage of the control and treated samples are higher than ideal, it is important to recognize that this product is low-fat and high in moisture content which can contribute to more shrinkage. This characteristic was not affected ($P>0.05$) by the addition of liquid whey.

CONCLUSIONS

Data from this study reveal that liquid whey can be added successfully to low-fat boneless cured ham with a resultant product that is very satisfactory in appearance, taste, and storage stability. Additional research is needed to evaluate further liquid whey as an adjunct for low-fat processed meat and discern the appropriate addition levels for various muscle foods.

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