FUNCTIONAL CHARACTERISTICS OF SOLUBLE SOY PROTEIN CONCENTRATE IN MEAT SYSTEMS

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INTRODUCTION

Non-meat protein binders have been used many years in global processed meat production. The principal non-meat proteins used in the meat industry are proteins derived from dairy products and proteins derived from the soybean. Evaluation of non-meat proteins for functional characteristics or/and emulsion stability has been a broad area of research in recent years.

A review of the literature shows research evaluations in two systems - the laboratory evaluation in a "model system" and the pilot plant or plant evaluation in a "real" meat system. Evaluations made in each of these systems can be further divided into the evaluation as binder or emulsifier and evaluation as a meat replacer or substitute.

L. H. Roberts' presentation to The 1974 Meat Industry Research Conference summarized the past literature on functional non-meat proteins. The 1974 G. Puski review of plant protein emulsification properties and methodology detailed the various model system tests.

The Swift, et.al. (1961) method for emulsion capacity was dependent upon a drop in emulsion viscosity during oil addition. The Hayes (1974) emulsion test provides a more sausage-like system utilizing a 1-5-5 protein, water, fat ratio in a bowl cutter.

The Yasumatsu, et.al. (1972) method of creating an emulsion in a homogenizer and centrifuging, is an easy, rapid evaluation for protein functionality. More recent variations and modifications of these tests have been published by Hermansson, et.al. (1975), Terrell, et.al. (1975), Gonzales, et.al. (1975), Randall, et.al. (1976), Sofos, et.al. (1977), Sofos, et.al. (1977), Pizza, et.al. (1978), Kwasiniewska, et.al. (1978).

Kinzella (1978) reviewed the various parameters of testing and usage which contribute to soy proteins functional properties. Hermansson (1978) discussed the methodology of evaluating protein's functional characteristics.

A protein's lipid interactions can be vastly different among fat absorption, fat emulsification or stability and emulsification capacity. The fat absorption or fat holding capacity of a protein may be high while fat emulsification or stabilization very minimal. A protein may demonstrate an extremely stable emulsion while possessing an extremely low emulsion capacity. These functional properties have been associated with various protein characteristics such as solubility, protein content, molecular weight, dispersibility, etc.

The need for basic research in protein functional characterization increases with each new protein introduced. There is an increasing need for quick protein screening or elimination for companies with limited laboratory facilities. The various protein requirements between countries and among sausage factories is vast. Many end users are requesting a quick test indicating a protein's functional characteristics.

The closer a model system parallels the real system the more applicable the results. Variation in sausage production processes and raw materials world wide create disadvantages for standard model systems. The recent use of "rind/fat emulsion" systems in world sausage preparation has made evaluation of non-meat proteins extremely important. Many of these "rind/fat systems" utilize the maximum functionality of a non-meat protein. Creation of a stable emulsion by using the least amount of costly myosin-rich meat protein is the goal of "rind/fat emulsion systems."

Several parameters influencing a simple test acceptable for world wide evaluation are the following:

1. Quick, reliable evaluation or screening of non-meat proteins resulting in visually detectable differences.
2. Evaluation that requires minimal skill, inexpensive and readily available equipment.
3. Evaluation that closely parallels major end use systems.
4. Evaluation that displays functional properties necessary in stress or marginal emulsion systems.

The evaluations conducted show various results in model systems that more closely approximate a meat or sausage emulsion. These evaluations are marginal or stress systems that display differences between and among various non-meat protein binders.

MATERIALS AND METHODS

A soluble soy protein concentrate (68% protein) STA-PRO(TM) 3000 was compared to a commercial food soy protein isolate (90% protein). Corn oil (68°F) was used as the lipid in emulsion preparation.

A Waring(TM) blender at 12,600 rpm was used for emulsion formation. Water (55°F) and salt were added to the blender jar. Soy protein was added while blending. The slurry was blended for 30 seconds for thorough dispersion. Corn oil was slowly added to the protein solution. The emulsion was blended for 1 minute after oil addition.

Three variables comparing the soluble soy protein concentrate to soy protein isolate were run.

1. An emulsion consisting of a 1-7-7 ratio of protein, water and fat
2. The same 1-7-7 ratio of protein, water and fat combined with 2% sodium chloride
3. A 1-10-28 ratio of protein, water and fat combined with 2% sodium chloride and heated to 70°C.

RESULTS

The 1-7-7 emulsion without NaCl displayed equal fat emulsification using the soluble soy protein concentrate as compared to soy protein isolate. The 1-7-7 emulsion with a 2% NaCl addition showed superior emulsion viscosity or thickness using the soluble soy protein concentrate. The isolate displayed a very obvious liquid-like viscosity.

The 1-10-28 emulsion resulted in complete emulsification by the soluble soy protein concentrate.

Emulsion stabilization at a temperature of 70°C was displayed by the soluble soy protein concentrate. The 1-10-28 emulsion formed by soy protein isolate developed poor emulsion viscosity and resulted in breakage upon heat treatment at 70°C. An oil separation was obvious upon heating. Viscosity measurements were taken with a Brookfield Helipath Viscometer to confirm visual observations.

A second evaluation using frozen pork fat trimmings (68.0% fat) was prepared in a Seydelmann K 21 table cutter. The emulsion consisted of 50% pork fat trimmings, 40% water and 10% protein. A 2% NaCl level was added to closer simulate a sausage system. The two proteins compared in this system were the soluble soy protein concentrate and a soy protein isolate. The materials were added to the chopper and chopped on low speed for 8 minutes. Samples were taken every 30 seconds for stability evaluation. A noticeable change in viscosity became apparent after 1-2 minutes of chopping the soluble soy protein concentrate emulsion. The isolate emulsion seemed stable throughout chopping duration. Samples taken were formed into 100 gram patties and cooked on a 325°F grill 2 minutes per side. The resulting cook yield displayed more shrink in the concentrate emulsion during the first minute of chopping. A steady increase in yield was displayed by the concentrate as chopping time progressed. The isolate was stable averaging 80.0% cook yield while the soluble soy protein concentrate increased from 74% to 94% cook yield. Repetitions of this evaluation were completed stuffing the emulsion into 28 mm cellulose frankfurter casings and cooking through a normal frankfurter cycle. The soy protein isolate emulsion exhibited fat caps on all links at each chopping time. The soy protein concentrate did not display fat caps on any links at any chopping time.

SUMMARY

A quick economical test to screen non-meat proteins can be utilized to give indications of functional properties. The use of a test system similar to the desired application yields more applicable results. An example is salt addition and fat level similar to an emulsion system. Formulating a stress system in pilot size processing equipment is reliable for simulation of mechanical shear, temperature variations, raw material variations, etc.

Functionality of the soluble soy protein concentrate is equal to or better than soy protein isolate in the systems tested. The 1-7-7 emulsion without salt exhibited the concentrate's ability to stabilize or emulsify. The 1-7-7 with salt demonstrated the ability to emulsify in a salt system. The 1-10-28 protein, water, fat emulsion displayed high emulsion capacity and superior stability when heated to 70°C. A system more closely simulating meat processing equipment and procedures exhibited increases in stability, but dependent upon mechanical shear.

The evaluations made display visual differences and variations due to many factors. Types of oil or fat, mechanical shear, temperature, handling procedures and material combinations are just a few parameters that determine testing results. A quick screening or functionality indicator can be usefully applied in emulsion meat systems.

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