FORMULATION AND DEVELOPMENT OF A READY TO EAT EXTRUDED TEXTURIZED CANNED SOYA PRODUCT

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DECLARATION

The work described in this thesis was carried out at the Raigam marketing services (pvt) Ltd, Kiriwattuduwa and Faculty of Applied sciences under the supervision of Mr.Hementha Siyambalagoda and Mr. M.C.N.Jayasooriya. A report on this has not been submitted to any other university for another degree.

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Affectionately dedicated to my ever loving parents

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ABSTRACT

FORMULATION AND DEVELOPMENT OF READY TO EAT EXTRUDED TEXTURIZED CANNED SOYA PRODUCT

The soybean (U.S.) or soya bean (UK) (*Glycine max*) is an annual plant that has been used in China for 5,000 years as a food and a component of drugs. Soy contains significant amounts of all the essential amino acids for humans, and so is a good source of protein.

There is no any substitute food product for the vegetarians like meat balls. My major objective was the fulfillment of above blank and produces nutritional and healthy food products for all people from Soya for reasonable price.

To the accomplishment of my objective, four types of (such as chicken flavor, Devilled chicken, Fish flavour and curry flavour) soya based extruded textured ready-to-eat canned food products were developed. Here I had to face many challenges. i.e. formulation of a soya nugget like meat ball using extrusion technology. Here I had to more concern on size, shape, texture of the nugget, to develop a high quality nugget special type of cutter die was made. To improve the structure of the nuggets various types of binders such as isolated soya protein (ISP), xanthan, and corn starch were used. Out of them isolated soya protein was the best binder and small amount of cornstarch was also added. Undesirable beany flavour of soya flour was mass by adding various combinations of spices to flour mixture. Here defatted soya flour was used to in soya nugget formation.

In manufacturing process, hygienic conditions of workers and sanitary conditions of machines and equipments were highly concern. Microbial contaminations are directly affected to the quality and shelf life of the canned products.

When selecting the can type, the pH of the final product was play very important role. The pH of the final product vary between 5.1-5.7. So I was selected A1-SR can. It is resistance to pH 3.5 – 6.5 and also resistance to sulfur staining.

The critical factors of the canned products are the exhausting time, time temperature combination of the canning process, internal preasure of the retorter...etc. Those conditions should be sufficient to destroy the microbes and their spores in to desirable level present in the can. *Clostridium botulinum, Clostridium perfringens, Bacillus cereus, Listeria monocytogens, Staphylococcus aureus, Vibrio parahaemolyticus* are the some of pathogenic microbes present in canned foods. Here exhausting time was 7 min and retorting condition was 30 min at121°C under 1.5 bar pressure. Micro biological test (commercial sterility) was done at the industrial technical institute. According to results of that series of tests it was found that the product was commercially sterile.

Can was seamed by using a two roller can seaming machine. Seaming quality was evaluated by measuring actual can attributes against standard values. i.e. seam length 2.8 – 3.2mm, Body hook 1.9 – 2.1mm, Cover hook 1.73 – 2.05mm, Actual overlap >1.02, and Overlap % minimum 45%.

The variation of pH and other physical quality characteristics of final product were measured every week for about 2 months. There was no significant change of pH and in other quality characteristics.

Sensory evaluation revealed that the highest acceptance was for the Raigam products than other meat ball curry available at market.

Content

CHAPTER 03

MATERIAL AND METHODOLOGY

ABBREVATIONS

°C:	Celsius
min:	minute
NSI:	Nitrogen Insoluble Index
PDI:	Protein Dispersibility Index
ISP:	Isolated Soya Protein
i.e.:	that is
etc:	etcetera
SMS:	Sodium metabi Sulphate
BHA:	Butylated hydroxy anisole
TVP	Textured vegetable protein
TSP	Textured soya protein
MSG	Mono sodium glutamate

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CHAPTER 01
INTRODUCTION

1.1 Background

Textured soya protein (TSP/TVP) is a most popular imitation for meat not only among the vegetarian but also among others. Therefore many types and various flavored of TVP products can be seen in market. But we cannot direct consume it and we have to cook it after purchasing. Actually relatively it is a time consuming process when concern with day to day life of people those who are competing with time. As well as it is very difficult to find a pre-cooked and ready-to-eat textured soya product in the market. Although various types of pre-cooked and ready-to-eat meat and fish products can be available in the super markets. But they are very expensive while causing several health problems to consumers due to content of high level of fats and cholesterol and other chemical additives. Such as preservatives, colors, flavors. As well as there is no any substitution food products like meat balls for the vegetarians. My major objective was the fulfillment of above blank and produces a nutritional and healthy food product for all people for reasonable price.

On the contrary according to the FDA, "Soy protein products can be good substitutes for animal products because, unlike some other beans, soy offers a "complete" protein profile. Soybeans contain all the amino acids essential to human nutrition, which must be supplied in the diet because they cannot be synthesized by the human body. Soy protein products can replace animal based foods which also have complete proteins and contain more saturated fat in the diet." (2005)

Raigam marketing services (pvt) Ltd. is a company engaged in the process of manufacturing many type of food products range of rice based products, Herbal products (including neeroga peyawa, neeroga paspanguwa), Biscuits, Iodated salts, instant beverages (coffee, Gango, Raigam X), and soya based extruded products (TVP) including various shapes and flavors (chicken, fish, devilled chicken, polos, cuttle fish, prawn) etc. and marketed under the brand name "Raigam". They are the market leader of the engaged in manufacturing of extruded textured soya products in Sri Lanka.

Therefore the Raigam marketing services (pvt) ltd was selected as a facilitator to carry out my research work.

1.2 Objectives

1.2.1 Overall Objective:

- Formulation And Development Of a Ready-To-Eat Extruded Textured Soya Product

1.2.2 Specific Objectives:

- Studying the textured vegetable protein (TVP) manufacturing process.
- Selecting the most appropriate types and amounts of ingredients and developing newer recipies for soya nugget and four types of flavored curries (chicken, fish, deviled chicken and curry) in order to offer the highest flavor and texture appeal
- Studying the product canning process
- Studying the shelf life evaluation methods of canned products
- Studying the microbial count methods (commercial sterility) in canned products.

CHAPTER 02

LITERATURE REVIEW

2.1 Soya plant

Scientific name: *Glycine max*

Vernacular Names: Sinhala/ Tamil/ English : Soya

Classification:

Family: Leguminosae

Sub family: papilionoidae

Genus: *Glysine*

Species: *max*

2.2 History

The soybean (U.S.) or soya bean (UK) (*Glycine max*) is a species of legume native to East Asia. Soya bean is one of the oldest crops of the world. It has been considered as a "miracle" crop due to its good quality oil and protein content and soil enriching properties. It is an annual plant that has been used in China for 5,000 years as a food and a component of drugs. Its plant is bushy with height ranging from 0.75 to 1.25 m, branching densely depending on cultivates and growing conditions. Soy contains significant amounts of all the essential amino acids for humans, and so is a good source of protein. Soybeans are the primary ingredient in many processed foods, including dairy product substitutes. (M. Ahamed 1984)

2.2.1 Origin and Distribution

The origins of the soybean plant are obscure, but many botanists believe it to have derived from *Glycine ussuriensis*, a legume native to central China. The soybean has been used in China for 5,000 years as a food and a component of drugs. From china, soya bean cultivation is spreaded to different countries. Such as Japan, Korea and throughout the south Asia, Europe and America. Soya bean was first introduced to Sri Lanka in 1947. (H.P.M.Gunasena and .H.M.G. Herath 1987)

Among the legumes, the soybean, also classed as an oilseed, is pre-eminent for its high (38-45%) protein content as well as its high (20%) oil content. The bulk of the soybean crop is grown for oil production, with the high-protein defatted and "toasted" soy meal used as livestock feed. A smaller percentage of soybeans are used directly for human consumption.

2.3 Seed morphology

Soya bean seed is a typical legume seed. it is different in size, shape and color depending on the variety. They range from small round beans to large, oblong, flattened seeds. Yellow, brown, green and black or combination of these colored seed can be seen. Mature seeds are made of these basic parts. Such as the seed coats, the embrayo and one or more food storage structures. (Liu.K.1999)

2.4 Economical value of Soya bean

There are several reasons for soya beans as an economical and valuable agricultural commodity. Such as

- Soya beans have favorable agronomic characteristics and soil enriching properties due to Nitrogen fixation ability.
- Soya beans have a unique chemical composition. it contains about 40% protein and 20% oil. (Liu.K, 1997)
- The protein and oil components in soya bean are high not only in quantities but also in quality. It is low in saturated fats and free of cholesterol. (Aoyagi,1979)
- Soya protein contains all the amino acids needed by the body and It is also contains many minor substances known as phyto-chemicals. (Liu.K 1999)
- Soya beans have versatile end uses, including human food, animal feed and industrial material.

2.5 Nutritional values of soybeans

Soybeans are very rich in nutritive components. Besides the very high protein content, soybeans contain a lot of fibre and are rich in calcium, magnesium. The soy protein has a high biological value and contains all the essential amino acids.
Soybeans are rich in unsaturated fatty acids and low in saturated fatty acids, which need to be avoided.

Table: 2.1 Nutritional values of soybeans (per 100g):

Water	8.5 g
Energy	416 kcal
Energy	1741 kJ
Protein	36.5 g
Fat (total lipid)	19.9 g
Fatty acids, saturated	2.9 g
Fatty acids, mono-unsaturated	4.4 g
Fatty acids, poly-unsaturated	11.3 g
Carbohydrates	30.2 g
Fiber	9.3 g
Ash	4.9 g
Isoflavones	200 mg
Calcium, Ca	277 mg
Iron, Fe	15.7 mg
Magnesium, Mg	280 mg
Phosphorus, Mg	704 mg
Potassium, K	1797 mg
Sodium, Na	2.0 mg
Zinc, Zn	4.9 mg
Copper, Cu	1.7 mg
Manganese, Mn	2.52 mg
Selenium, Se	17.8 µg
Vitamin C (ascorbic acid)	6.0 mg
Thiamin (vitamin B1)	0.874 mg
Riboflavin (vitamin B2)	0.87 mg
Niacin (vitamin B3)	1.62 mg
Panthotenic acid (vitamin B5)	0.79 mg
Vitamin B6	0.38 mg
Folic acid	375 µg
Vitamin B12	0.0 µg
Vitamin A	2.0 µg
Vitamin E	1.95 mg

[Source: USDA Nutrient Database for Standard Reference 1997]

2.6 Problems upgrading with soya bean as a human food

Although, soya bean is versatile, it has little direct use. Because of it's,

- High satiety value caused by high oil content
- Bitterness and poor digestibility
- Green beany flavor
- Presence of anti-nutritional factors that include trypsin inhibitors, haemoglutanins and phytates.
- Long cooking time
- Tough and chewy in texture

2.7. Processing of whole soya bean

In order to obtain full complement of nutrients in soya beans, it is necessary to eliminate or inactivate the undesirable factors associated with it. these factors include trypsin inhibitors, haemoglutanins and phytates. Other undesirable factor is enzymes, such as lipoxigenase which is responsible for the beany flavour, unacceptable to Sri Lankan palates. (H.P.M .Gunasena and H.M.G .Herath. 1987)
Therefore when processing soya bean, all anti –nutritional agents should be destroyed to prevent the development of beany flavor.

2.7.1. Important considerations in soya bean processing

1) Potential beany flavour development

Lipoxigenase enzyme + Lipid substrate + added water = Instant beany flavour

Once this beany flavour is developed it cannot be eliminated. In intact dry beans, these reactions are separated and no beany flavour is present. When bean tissue is broken or damaged, though enzyme and substrate in the tissue are exposed, still no beany flavour is developed as long as the tissue remains dry. Addition of water, however results in instaneous beany flavour and off odor.

2) Anti-nutritional factors

Most important factor is trypsin inhibitor which is the most heat resistant anti-nutritional factor. Destroying trypsin inhibitor through complete cooking, that indicates the destruction of all anti-nutritional factors in soya bean during cooking. (Liu.K.1999)

2.8. Current trend in processing and utilization of soya bean in Sri Lanka

The main limitation in the use of soya bean for human consumption is the lack of know how in processing methods. Cooking methods and product must be developed to suit the food habits and local conditions.

Current researches are based on product development and extension in soya bean processing. These two activities are carried out under two well defined areas of processing and utilization namely. Home and village level and commercial level. At present around 28,000 MT of soya bean is required annually to service the major industries. (Gunasena and Herath ,1987)

2.9. Occurrence of Aflatoxins in soya beans

Aflatoxins are one of main group of mycotoxin. It is highly toxic and carcinogenic metabolite. It is produced by strains of the fungus *Aspergillus flavus* and *Aspergillus parasiticus*. Occurrence of aflatoxin is very low in soya beans in comparison with other commodities. (Bean et al, 1972)

Aflatoxins synthesis inhibition in soya beans was explained on the basis of zinc availability, which is low in amount and bound to phytic acid (Gupta et al, 1975). Zinc seems to play an important role in the bio synthesis of aflatoxin (Moygon et al ,1977). Stossel (1986) observed that seed coat integrity and low moisture content of harvest are responsible for the control of mold growth instead of Zn availability.

2.10. Uses of whole soya beans

Whole soya beans are processed and fermented in to different kind of food items.

Processed products are

- Soya beverage (milk)
- Cheese, Curd, Yoghurt and Ice cream.
- Soya bean oil

- Soya protein products
- Weaning foods
- Soya cereal snack and TSP made by extrusion cooking

2.10.1. Soy Flour

Soy flour is made from ground roasted soybeans. It is rich in high-quality protein and contains 2 to 3 times more protein than wheat flour. It is also an excellent source of iron, calcium and B-vitamins

There are two types of soy flour on the market. Natural or full fat soy flour contains all the original oils found in the soybean (between 18 and 20% of its content). Its low carbohydrate content makes it a good choice for diabetics. In defatted soy flour nearly all the oils from the soybeans are removed. Both kinds of flour will boost the protein content of recipes, although defatted soy flour contains more protein than full-fat soy flour. Soy flour can be used in small quantities in almost every baked product. Soy flour is gluten-free, and therefore cannot entirely replace wheat flour. However, if 15% of the flour called for in a bread recipe is replaced with soy flour, it will make the bread denser with a moist texture and a wonderful nutty flavour. Soy flour also decreases the quantity of fat absorbed in the dough of fried foods like doughnuts. It also adds a rich color and tenderness to the final product. In addition, one tablespoon of soy flour mixed with a tablespoon of water can be substituted for an egg when baking, therefore reducing the amount of cholesterol. These are some of the reasons why bakeries, and biscuit factories, in particular, frequently use soy flour in their recipes. Soy flour must be kept refrigerated or in the freezer.

Defatted soybeans where special care was taken during desolventizing (not toasted) in order to minimize denaturation of the protein to retain a high Nitrogen Solubility Index (NSI), for uses such as extruder texturizing (TVP). It is the starting material for production of soy concentrate and soy protein isolate.

- Defatted soy flour is obtained from solvent extracted flakes, and contains less than 1% oil.
- Full-fat soy flour is made from unextracted, dehulled beans, and contains about 18% to 20% oil. Due to its high oil content a specialized Alpine Fine Impact Mill must be used for grinding rather than the more common hammer mill.

- Low-fat soy flour is made by adding back some oil to defatted soy flour. The lipid content varies according to specifications, usually between 4.5% and 9%.
- High-fat soy flour can also be produced by adding back soybean oil to defatted flour at the level of 15%.
- Lecithinated soy flour is made by adding soybean lecithin to defatted, low-fat or high-fat soy flour to increase their dispersibility and impart emulsifying properties. The lecithin content varies up to 15%.

Soybeans are the primary ingredient in many processed foods, including dairy product substitutes (e.g., margarine, soy ice cream, soy milk, soy yogurt, soy cheese and soy cream cheese), as well as Crisco, soybean oil, tofu, veggie burgers, soy nut butter, soy crisps, among others. Soybeans are processed to produce a texture and appearance similar to other foods (e.g., butter, ice cream, milk, yogurt, cheese, lard, olive oil, ground beef, peanut butter, potato chips, etc.) and are readily available in most supermarkets.

According to the FDA, "Soy protein products can be good substitutes for animal products because, unlike some other beans, soy offers a "complete" protein profile. Soybeans contain all the amino acids essential to human nutrition.

2.10.2. Soya protein

Soy protein has been used since 1959 as ingredients for its functional properties in a variety of foods such as salad dressings, soups, vegetarian foods and meat imitations. Its functional properties are emulsification and texturizing. Recently the popularity of soy protein is increasing, mainly because of its health benefits. It has been proven that soy protein can help to prevent heart problems and many countries allow health claims for food, which are rich in soy protein.

2.10.2.1 Categories of soy proteins

Soy proteins can be divided into different categories according to their production method:

- Soya protein Isolate
- Soya protein concentrate
- Textured soya protein

2.10.2.2. Benefits of Soy Protein

Soy protein is very healthy: it is very low in fat, contains no cholesterol and contains phytochemicals. The main phytochemicals in soy protein are isoflavones, saponins and phytic acid. These phytochemicals are strong antioxidants but have many other properties. Soy protein and its associated phytochemicals seem to reduce heart disease, osteoporosis and risk of cancer. (Liu.K.1999)

Soy protein has key nutritional qualities that support energy levels, stamina, and sports performance (better lean muscle mass, endurance and recovery time).

1. Soy protein is rich in "branched-chain amino acids" which the body can burn as "fuel" to produce energy.
2. As a complete protein, soy helps to build and maintain lean muscle mass.
3. Soy may help support a hormonal profile that promotes muscle formation.
4. Soy may help sustain endurance levels during exercise.
5. Soy helps support a healthy cardiovascular system (critical for exercising or an active lifestyle).
6. Soy may support better antioxidant health for exercise than common whey protein.

2.10.3. Soya Protein Isolate

After the process of removing the hull and oil from the soybean, defatted flakes are produced. The protein is then extracted and the product is called soy protein isolate. It contains no less than 90% protein, which makes it the purest form of soybean protein on the market. Soy protein contains nearly all essential amino acids in amounts sufficient to stay healthy. Other amino acids required for health are produced by the body. Once consumed, soy protein is broken down, rearranged to from antibodies and enzymes essential for human growth and maintenance.

Isolated soy protein is a valuable food ingredient, in that it is high in protein while remaining low in fat and cholesterol. It increases a product's shelf life, improves the taste and the texture of food, and acts as an excellent emulsifying and gelling agent. Manufacturers acknowledge the benefits of soy protein isolate, adding it to recipes for

breads, baked goods, baking mixes, breakfast cereals, meals-in-a-glass, milkshakes, soups, pastas, sauces, infant formulas and food supplements, among others

2.10.4. Soy protein concentrate

Soy protein concentrate is basically soybean without the water soluble carbohydrates. it contains about 70 percent of protein.

2.10.5. Textured soya protein

Textured soya protein, often called TSP, is made from soya protein concentrate by giving it some texture. TSP is available as dry flakes or chunks. It will keep its structure when hydrated. Hydrated textured soya protein chunks have a texture similar to ground beef. It can be used as a meat replacement or can be added to meat.

2.10.6. Soya Lecithin

Soybean lecithin is extracted from crude soybean oil during the degumming process. Crude soy oil contains between 1 and 3% lecithin. Lecithin is useful for stabilization, antioxidation and crystallization of commercial products and can also be used as an emulsifier in products that high in fat.

2.11. What is Extrusion?

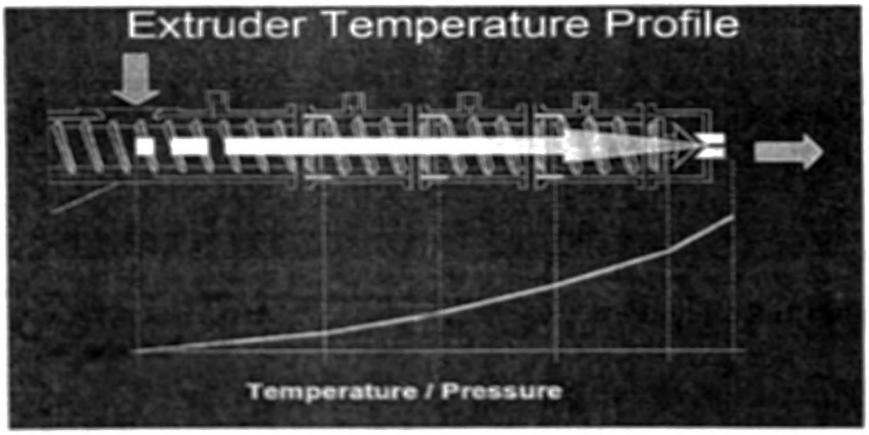

Fig: 2.1 extruder temperature profile (angela 2007)

Extrusion is Cooking under pressure. moisture & elevated temperature. Extrusion technology is a new type of economical and practical method widely used in food industry.

2.11.1. Some Advantages of Extrusion

Adaptability : the production of an ample variety of products is feasible by changing the minor ingredients and the operation condition of the extruder. The extrusion process is remarkably adaptable in accommodating consumer demand for new products.

Product characteristics: A variety of shapes, textures, colors, and appearance can be produced, which is not easily feasible using other production methods.

Energy efficiency: extruders operate with relatively low moisture while cooking food products, so therefore ,less re-drying is required.

Low cost: extrusion has a lower processing cost than other cooking and forming processes. When using the extrusion process, can save the raw material by in 19%, labour by in 14%, and capital investment by in 44%. And extrusion processing also requires less space per unit of operation than traditional cooking systems.

New foods: extrusion can modify animal and vegetable proteins, starches, and other food materials to produce a variety of new and unique snack food products.

High productivity and automated control: An extruder provides continuous high throughput processing and can be fully automated.

High product quality: Since extrusion is a high temperature/ short time (HT/ST) heating process ,it minimizes degradation of food nutrients while it improves the digestibility of proteins (by denaturing) and starches (by gelatinizing). Extrusion cooking at high temperatures also destroys antinutritional compounds. i.e. trypsin inhibitors and undesirable enzymes, such as lipase,lipoxidases, and micro organisms.

No effluent: This is a very important advantage for the food and feed industries, since new environmental regulations are stringent and costly. Extrusion produces little or no waste streams. (mian.N.Raiz 2000)

2.11.2. Most commonly used extruders

Single screw (dry) extruder

Single screw (wet) extruder

Twin screw (wet) extruder

Table 2.2 Extruder characteristics

	Single screw (dry)	Single screw (wet)	Twin screw (wet)
Heat source	Primary internal	Primary external	Primary external
Screw speed	> 600 RPM	300-400 RPM	300-400 RPM
versatility	Moderate	High	Very high
Cost/ capacity	Moderate	High	Very high

(source angela 2007)

2.12. Texturization

The process of Re-engineering of native protein into a conformation that is similar to the fibrillar structure of muscle tissue is called as texturization of protein.

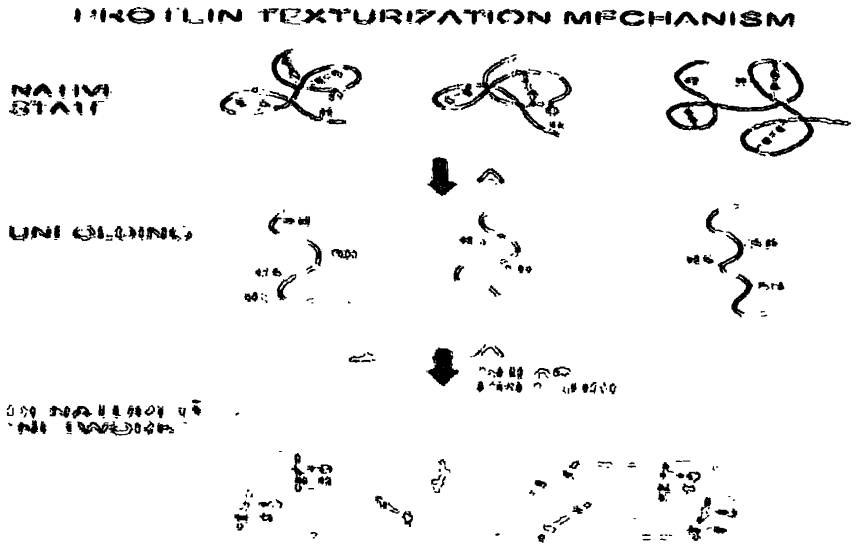

Fig: 2.2 protein texturization mechanism (angela 2007)

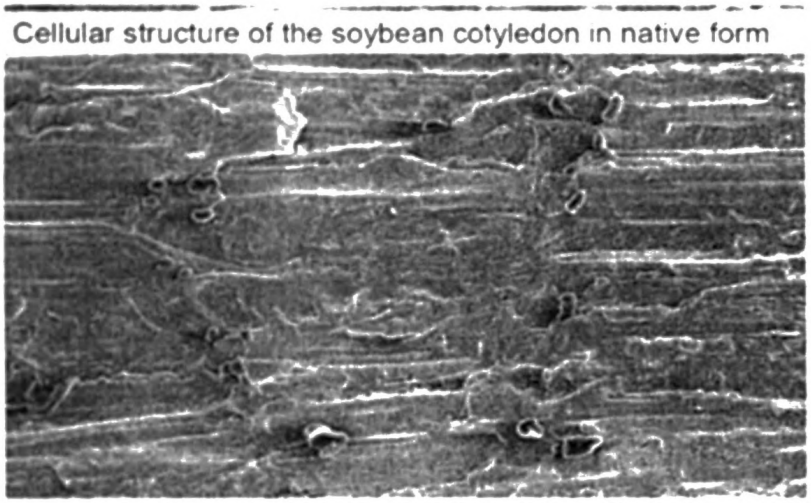

Fig: 2.3. Cellular structure of the soybean cotyledon in native form (angela 2007)

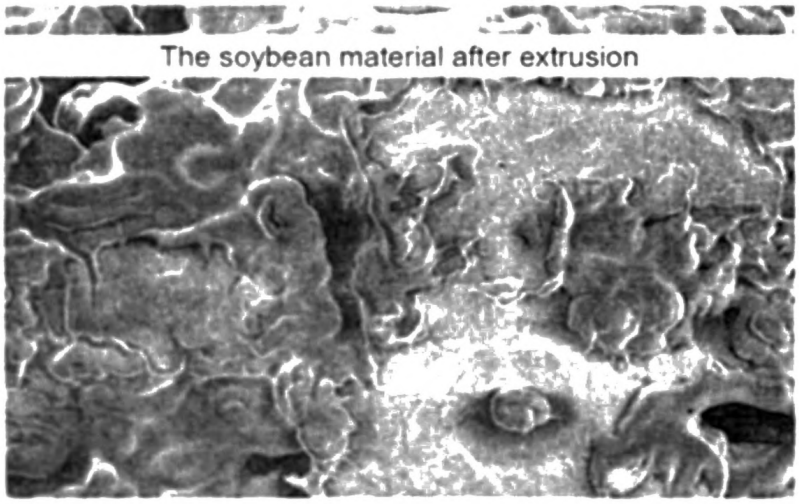

Fig: 2.4. The soybean material after extrusion (angela 2007)

2.13. Food canning

Fig: 2.5 various types of cans (www.ehcan.com)

2.13.1. What does canning do?

Canning is safe method for preserving food if practiced properly. In canning process foods placed in containers and heating it to a temperature that destroys micro-organisms that cause food to spoil. During this heating process air is driven out of the can and a vacuum seal is formed. This vacuum seal prevents the entrance of air into the product that bringing micro-organisms.

Pressure canning is the only safe method of preserving vegetables, meats, poultry and seafood. Cans of food are placed in 2 to 3 inches of water in a special pressure cooker which is heated to a temperature of at least 240° F. This temperature can only be reached using the pressure method. *Clostridium botulinum* is the main reason why pressure processing is necessary. Though the bacterial cells are killed at boiling temperatures, they can form spores that can survive in these temperatures. The spores grow well in low acid foods, even absence of air, such as in low acidic canned foods like meats and vegetables. When the spores begin to grow, they produce poisonous botulinum toxins.

2.13.2. Some positive points of tin cans

- Higher durability than glass and plastic
- No leaching of container materials into food with new Linings.
- Better utilization of Available storage area
- Longer Storage Life

2.13.3. EPA coating can

Epoxy resins have been used as components of coatings for food and beverage cans for more than 50 years. Epoxies based on bisphenol A (BPA)(4,4[prime]-isopropylidenediphenol; 2,2-bis(4-hydroxyphenyl propane) are cleared by the United States Food and Drug Administration (FDA) for use as the food-contact surface of coated cans.

2.13.4. Process of canning

The contents of cans are an ideal growth media for micro-organisms. they will support of harmful anacrobes over aerobic organisms in the hermetically sealed canned products. Therefore if make some mistakes in canning it may cause to death of consumers. If can content will be contaminated it is toxic before noticeably spoilt. Therefore following requirements should be highly consider in canning process.

1. Pre processing hygiene of factory environment and condition of the raw materials.
2. Container seal integrity.
3. Complete thermal destruction of micro organisms.
4. Post processing hygiene of the product.

2.13.5. Pre processing hygiene of factory

Factory should be located in areas free from dust objectionable odors and others contaminants. There should be adequate facilities for the disposal of effluent locates where such distance as to avoid possibility of contamination. Factory environment should be free from insects, birds,, and pest to avoid contamination.

The factory structure should be planned with considering essential requirement in the production area, such as insect screen on all opening windows (removable for cleaning), plastic strip barriers on all door ways to use during processing, enough lighting and ventilation (air conditioning system)

The production area should be separated to avoid contamination. The product from micro organisms, foreign bodies, such as should be separated manufacturing area for filling, seaming, sterilization, area for cooled and dry freshly process cans and operation area for the cartooning and palletizing. Although there should be separated stocks for unused empty cans, cartoons, wrapping materials and final finish goods.

There is a main risk to contaminate the product from water. Therefore portable water stored in clean tank without contamination should be used. The tests for colour, taste, odor, turbidity, pH, hardness, free residual chlorine, suspended solid, total aerobic plate count, total *coliform* and nitrate iron should be done periodically.

The personal hygiene of the workers also is a main reason for product contamination. Therefore the separate person should provide to area, which have high accumulation

probability such as pre processing and post processing section (cutting room and packing room). Protective over clothing, dust marks, hair nets, should be provided to the workers. Workers must be washing their hand thoroughly using soap. Fingernails must be kept short and clean. Wearing of watches, jewelry should be prohibited personal items must be left in lockers at the out side the production area. The consumption of food and drink must be prohibited in the production area. Specially injured person with cuts wound their hands and legs and infectious person should not be work.

2.13.6. Container seal integrity

Containers should hermetically seal to avoid contamination specially during cooling of the cans. Here double seaming technology is used. The hermetically seal formed between the can body and can end is reheard to as double seam. There are three steps as following.

1. Body hooks butting (primary seal formation)
2. Actual overlap (secondary seal formation)
3. Tightness rating (ensuring the seam is held under sufficient compression)

2.13.7. Heat sterilization of the product

The hermetically sealed cans are sterilized to sufficiently high temperature and sufficiently long time to destroy microbial and enzyme activity. As a result of that canned food have long shelf life. But over heat sterilization will be cause loss of sensory quality and nutritional value of the food. Therefore determination of the optimum temperature and time for the sterilization is necessary. In order to determine the process temperature the pH value of the content is important. The food which pH higher than the 4.6 are required full sterilization process that temperature based on 121 °C. The foods which pH lower than 4.6 have high acid content do not want fully sterilization process. The reason for that the foods have high pH value allows to grow spore forming anaerobic pathogenic bacteria such as Clostridium botulinum. But foods have low pH value does not allow harmful spore forming bacteria.

In order to determine the process time for given food it is necessary to have information on heat resistance of micro organisms or enzymes and the rate of heat penetration in food

container within the retort. Information about heat resistance micro-organisms is described from D and D_O values of specific micro-organisms.

The time taken to reduce spores to 10% from the 100% at the specific temperature is described as D value. If that temperature is 121 °C D value is called D_0 value. Thermal death time (TDT) is calculated from Do values of specified micro-organisms. TDT is the shortest time, which required to killing all micro-organisms at a specified temperature with a minimum lose of nutrient.

Table 2.3. Some micro-organisms important in canning and their D_0 value

Organisms	D_0 (minutes)
spores of *bacillus stearo thermophilus*	4 -5
spores of *clostridium thermosaccarolyticum*	3 -4
spores of *clostridium nigrificans*	2 -3
spores of *clostridium botulinum type A and B*	0.1 -0.25

(Source G.M.Hall, 1997)

Rate of heat penetration of the food is the other factor to determine the process time. Saturated steam is the best media for heat sterilization. Heat penetration to the centre is faster in different condition. Those are the heat penetration is faster in small containers than in large containers. Also there is a fast heat penetration in liquid food than solid food. Therefore solid foods within sauce or liquid have fast heat penetration. Agitation of can using rotating retort also gives fast penetration. Metal containers are good on heat penetration than plastic or glass containers. Pressure of the steam will increase the temperature in the retort. The correct retort operation technique must be used to get maximum efficiency of steam.

F value is requiring minimum thermal process value to sterilize the product considering these entire requirements.

2.13.8. Post process operation

Sterilized cans are rapidly cooled to avoid over cooking. Also slow cooling of the cans will be caused to germinating growth of remain spores of thermophilic bacteria such as *Clostridium botulinum*. The water used to cool the process containers must be chlorinated because while the containers are hot due to the pressure difference of the head space of the cans slight possibility that a drop of cooling water could be pulled in to the can through a seam. There is a high risk of contamination the can content. Therefore water used for cooling process should be tested at least weekly for total aerobic plate count (TPC) and for coli form monthly. It should be in limit 100 organisms per ml at 20 -22 °C for 5 days for TPC and for coli form count no organisms per 100 ml 20-22 °C for 5 days according to SLS 873:1989. But high level of free chlorine cause to accelerate external corrosion of the containers. Therefore it should be in limit below 10 ppm. (Rangana.S 2000)

2.13.9. Reasons for spoilage of canned foods

2.13.9.1. Micro-organisms

The major causes of food spoilage are microbial growth. Canning is a method of food preservation involving heat. Canning a food increases the length of time that a food can be stored at room temperature. During the heating process certain micro-organisms that cause food spoilage are destroyed.

The types of micro-organisms that cause spoilage in foods are bacteria, Yeast, Molds. They contaminate food through air, soil, water or via the food handler. The growth of micro-organisms is affected by temperature, amount of water, amount of acids in the food and the presence of oxygen (air).

Canned foods provide a moist, yet oxygen free environment that favors the growth of certain micro-organisms. While most micro-organisms are destroyed in heating process, the organism that can survive in a moist, oxygen free environment and which is of most concern in home canning is *Clostridium botulinum*. This organism causes the often fatal disease known as botulism.

Clostridium botulinum is able to grow without oxygen (air) and thrives where there is little acid available. This particular micro-organism exists as a bacterial vegetative cell under favorable growth conditions, but reverts to a spore stage under favorable

conditions. The spores are very heat-resistant. yet can be destroyed during the canning process. If the temperatures reached during the canning process are inadequate, the spores will change in to cells, begin to grow inside the closed jar and produce the toxin that can be fatal. Times and temperatures for canning are based on those needed for the destruction of botulinum spores in the specific food product.

2.13.9.2. Enzyme

Chemical changes in food can also cause food spoilage. Such changes in canned foods are often caused by the action of enzymes which are not destroyed during heating.
Enzymes are proteins which are naturally present in plants and animals. In living plants or animals they are important because they help speed up the ripening and maturing process. However, when plants have been harvested or animal slaughtered, enzyme reactions often continue causing undesirable changes in a food product. Most enzymes deteriorate a food product under the same conditions which promote microbial growth. Canning or an equivalent heat treatment, stops enzymes from causing undesirable chemical changes in a food.

2.13.10. Effect of the acidity of food in canning

Foods are divided in to two groups for canning based on the amount of acid they contain. Most foods have a neutral pH or are slightly acidic. In food preservation, a food with a pH of 4.6 or lower is considered to be a high-acid food, while one with a pH above 4.6 is a low-acid food.

Directions for proper canning have been developed on the basis of low and high acid foods. Because micro-organisms are easily destroyed by heat when acid is present, high-acid foods can be canned in boiling water at a temperature of 212 °F. High acid foods include fruit and fruit juices: jams, jellies, and preserves: and pickles and pickle products. Temperatures higher than 212 degrees F are required to destroy the spores of *Clostridium botulinum* in low acid feds, which include vegetables, red meat, poultry, fish, cereals, and wild game. To reach temperatures higher than the boiling point of water (212 °F) , use a pressure canner. A temperature of at least 240 degrees of F is needed for destruction of *Clostridium botulinum* spores. Therefore canning of low acid food is done in a pressure

canner at 10 or 11 pounds of pressure (240°F or at 15 pounds of pressure (250°F). Adjustments in canner pressure are made according to elevation above sea level. (Frazier.W.C. and Westhof.D.C., 1978)

2.14. Some practices and procedures to avoid

DO NOT open-kettle can

This method involves pouring hot food into can and sealing without further heat processing. As the can and its contents cool, a vacuum forms to seal the product. This method is NOT RECOMMENDED for canning of perishable foods. Without sufficient heat to destroy bacteria, molds, and yeast in food, microbial growth is likely and the product will spoil, even though it is sealed.

DO NOT oven can

This method involves placing filled cans in the oven set at a specific temperature and "processing" for certain period of time. This method HAS NEVER BEEN RECOMMENDED as a safe procedure for a variety of reasons. There are no safe and reliable processing times or temperature settings established for canning in oven. Also ,dry heat or hot air , is not as efficient as steam or boiling water for the transfer of heat to the centre of the food in the can. Oven temperatures vary considerably between the "on" and "off" cycles. So heating is uneven. Also, the temperature of the food does not correspond to the oven setting. In an oven, excess pressure can build up inside the can, causing it to explode. The sudden temperature changes that occur when the oven is opened and the cans are removed could also cause the cans to explore.
Finally, besides the fact that oven canning can be dangerous, the end product would be under processed and thus could allow the growth of dangerous spoilage organisms, particularly *Clostridium botulinum*.

DO NOT can in the microwave or dishwasher

Canning in the microwave oven or dishwasher is NOT RECOMMENDED. Microwave ovens do not provide temperature above 212 degree F for long enough periods of time to make certain the *C.botulinum* spores are destroyed. Similarly, temperatures in dishwashers are not high enough to sterilize food.

DO NOT steam can

There are several brands of steams canners available on the market. These are not the same us steam pressure canners used for canning low acid foods. They are also different from the water bath canners. In the steam canners, the jars are not immersed in water as they are in the water-bath canner: therefore heat flow inside the steam canner may be uneven. The end result would be under processed food that would be susceptible to microbial spoilage and chemical changes.

DO NOT use chemicals or preserving powders unless recommended

Chemicals such as asprin should NEVER be used as a substitute for heat treatment on canning of food and CANNOT be relied upon to prevent spoilage or yield a satisfactory product. There is no safe ingredient that could destroy micro-organisms and extend the shelf life of a food as heat processing does.

DO NOT take shortcuts or experiment in canning

Use only tested, currently approved methods. The only safe canning method is a boiling water bath for high acid foods and a pressure canner for low acid foods.

DO NOT use jars, cans and lids which are not made especially for canning

Jars designed for commercial products such as peanut butter, coffee, pickles or vegetables may not withstand the heat treatment without breaking or may not accommodate standard two-piece canning lids. Mayonnaise or salad dressing jars that accommodate standard canning lids can be used for foods processed in boiling water canners but should not be used in a pressure canner.

DO NOT re-use or use zinc lids

Rubber rings used with zinc lids are not manufactured today. Old once should not be used. Get new metal two-piece lids with sealing compound for safe products.

- DO NOT over pack foods

  Trying to get too much food into one can may result in under processing and spoilage. Leave recommended amount of headspace when cans are filled.

- DO NOT use canned foods showing signs of spoilage

  Watch for bulging lids, leaks, off-odors or mold. If in doubt, DON'T TASTE. Dispose of the food so that it can not be consumed by humans or animals.

2.15. Spoilage of canned foods

Spoilage caused by chemical, biological, and physical hazards or all of them. Because of the several failures of the process the spoilage can appear. Spoiled cans are identified externally by blowing of the cans. But some time can content may be spoilage without external changes of the can appearance.

2.15.1. External changes of the cans during spoilage

Normally the ends of a can food are flat, which means that no evidence of swell bustling. If the pressure develops inside, the can goes through a series of distortions. Flipper ends are flat but with insufficient vacuum to hold the ends in place thus a sharp blow will cause to become convex but both ends may be pressed to their normal position. A Springer has both ends of the can bulged, but one or both end will stay concave if pushed in, an opposite flat end will pop out some to designate slight pressers in the cans not caused by gas production uses the terms flipper and Springer but by such thing as a poor exhaust, over filling ditining of the can, changes in temperature. But the can may have some outward characteristics at the start of gas production from either microbial or chemical causes or both.

2.15.2. Chemical changes

The most important kind of chemical spoilage of canned foods is the hydrogen swell. Due to the action of the acid of the food on the iron of the can realize hydrogen gases and the internal pressure of the can is increased. Hydrogen emition is favored by increasing acidifies of foods, increasing temperature of storage, imperfection of the tinning and lacquering of the interior of the can, a poor exhaust and presence of soluble sulfur and phosphors compounds. Other defects such as discoloration of the inside of the can and

food, production of off-flavors, cloudiness, off liquors or syrups, corrosion of the metal and loss of nutrition value are also caused by interaction between can and the contain food. In chemical spoilage the rate of blowing of the can is very slow and starts after long time of storage.

2.15.3.Bio logical spoilage

Biological spoilage of canned foods may result from survival of micro-organisms because of inadequate heat process or post contamination from cooling water through the container leakage.

Mesophilic bacteria, thermophilic bacteria, and their spores are the organisms that can be caused to spoilage of canned foods and thermophilic bacteria spores are more heat resistant than mesophilic bacteria spores. The three common types of spoilage by thermophilers are flats sour spoilage, TA spoilage, Sulfide Spoilage.

2.15.4. Flat sour spoilage

Flat sour spoilage is the ends of the can remain flat during souring. This type of spoilage cannot be detected by examine appearance of the can but must be detected by cultural method. The various species of bacillus that is able to form acid without gas formation in food may be mesophillus, facultative thermophillus, and obligate thermophillus. The spores of mesophillus are the least heat resistant and are usually killed by the heat processing. Surviving of obligate thermophillus, such as *Bacillus stearothermophillus*, would not cause spoilage unless the food were held hot for a while as in slow cooling or storage in the tropics, but facultative thermophillus could grow at ordinary temperatures. The sauce of the flat sour bacteria is usually comes from sugar starch or soil.

2.15.5. TA spoilage

The bacterium causing this type of spoilage is "thermophilic anaerobic not producing hydrogen sulfide" or for the species *clostridium thermosaccharolilicum*. This is a sugar splitting obligatory thermophilic, spore forming anaerobe that forms acid and gases in low and medium acid foods. The gas, a mixer of carbon dioxide and hydrogen, swell the can if it is held long enough at a high temperature and may eventually cause bursting. The

spoiled food usually has a sour odor. Since the organisms do not form colonies readily in agar, it is detected usually by the inoculation by the liver broth media.

2.15.6. Sulfide spoilage

This spoilage called sulfide or "sulfur stinker", caused by *Clostridium nigirificans*. The spores of this bacterium have considerably less heat resistance than those of flat sour and TA. Since these organisms are obligate thermophile require poor cooling heat processed foods or hot storage to its development. It forms black ferrous sulfide (FeS) colonies and realease hydrogen sulfides, when the can is opened.

2.15.7. Physical spoilage

Over filling, seam defects and bad handling also causes for the can spoilage. Over filling is caused to immediate swelling of the can during sterilized in the retort. Seam defects cause to microbial spoilage of the cans and bad handling cause to external and internal corrosion of cans.

2.16. Quality changes during thermal processing

Following quality changes are occurred during thermal processing because of over heating

Cook out

The denaturation of protein due to heat causes water loss from 9 to 28% . This water loss causes to curdled appearance in the contents called as "cooked out".

Vitamin loss

There are slight loss of B- group vitamins such as thiamin, riboflavin, nicotinic acid, folic acid, and cyanocobulamine in canned products than packeted soya products.

Flavor changes

Some flavor changes occur in the canned product when it exposes to high temperature. But if the product gravy will be contain spices, salt, and pepper that will be masked by them.

Textural changes

Excessive protein denaturation at the high temperature cause to textural changes and reduction of water holding capacity. Textural changes means, the meat ball nugget become soft with the time.

CHAPTOR 03

MATERIAL AND METHODOLOGY

3.1. Materials and methodology

3.1.1. Common ingredients for formulation and development of three types (curry flavor, chicken flavor, and fish flavor) of soya meat ball curries.

Coriander

Cumin

Fennel

Metty seeds

Turmeric

Cardamom

Cinnamon

Clove

Garlic

Curry leaves

Pepper

saera

Rice flour

Chili

Mustard

Ginger

Rampe

Curry leaves

Salt

MSG

Soya Lecithin

Vegetable oil

Nugget washed Water

BHA

3.1.2. Methodology for curry meat ball preparation

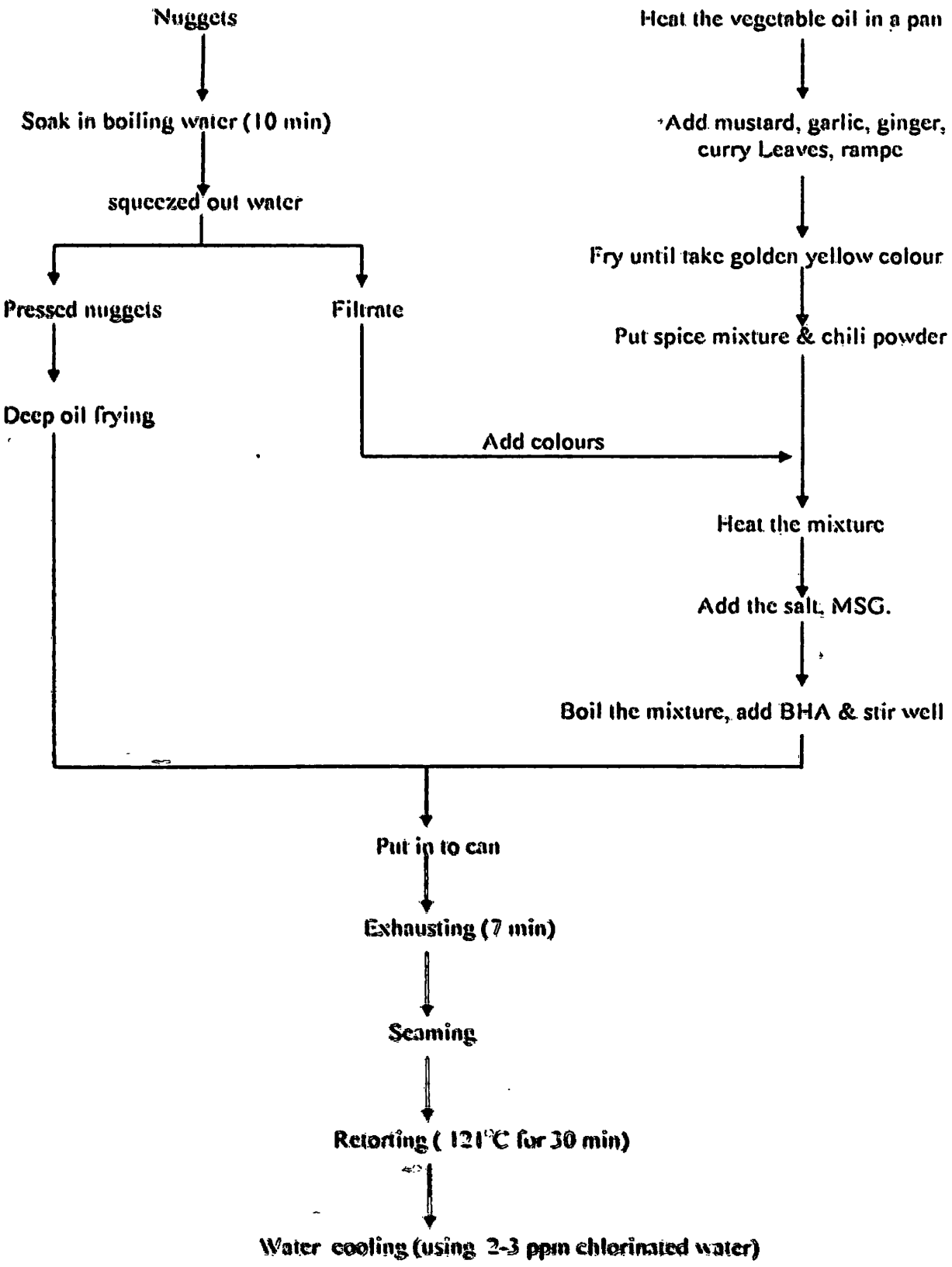

Fig:3.1 Flow chart of the curry meat ball preparation

3.1.3. Other ingredients used in formulation of chicken flavor and fish flavor soya meat ball

Chicken flavor

Tuna fish flavor

Sunset yellow color

Tomato sauce

Soya sauce

Oyster sauce

3.1.4. Methodology of chicken meat ball preparation

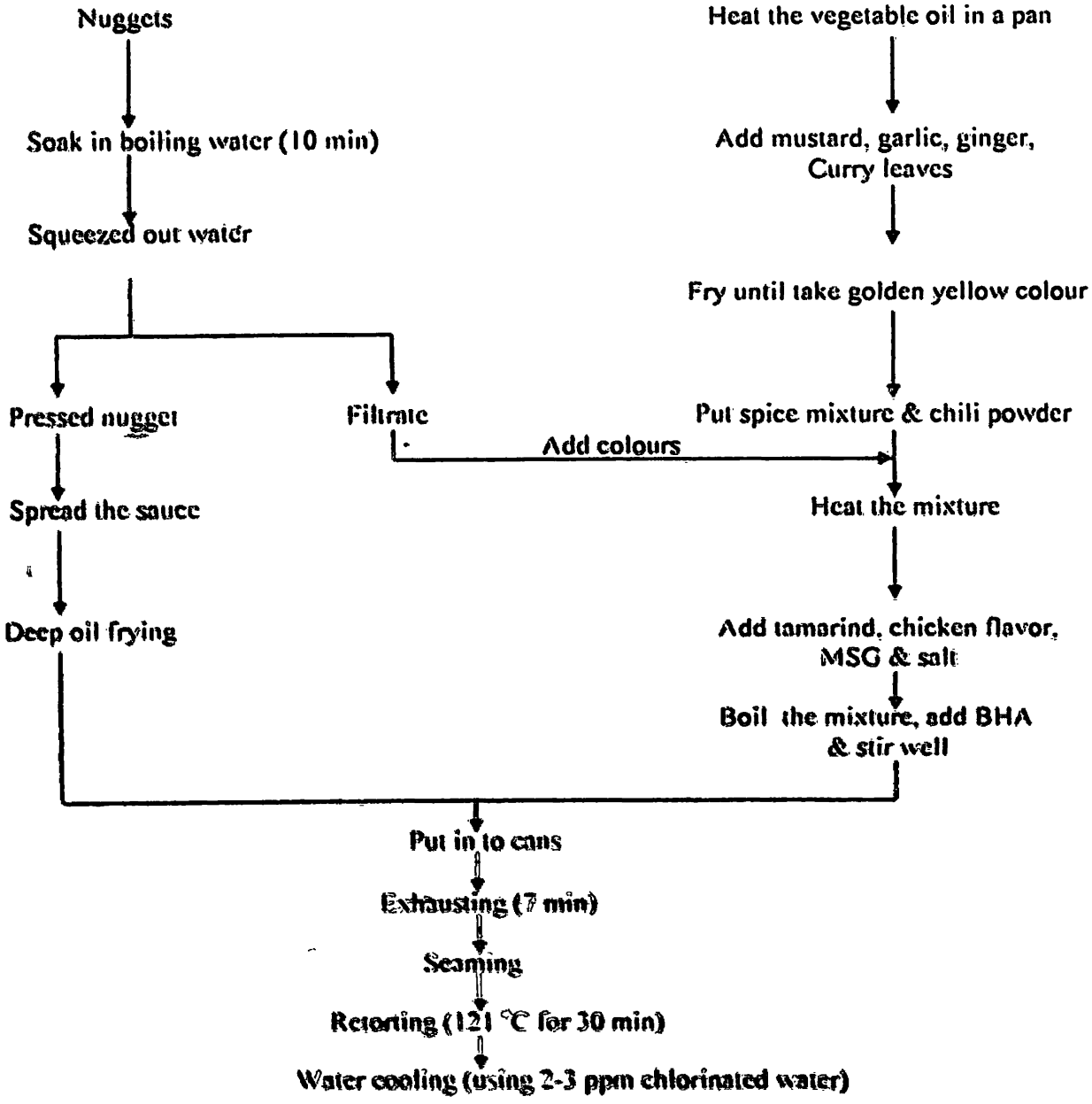

Fig: 3.2. Flow chart of the chicken meat ball preparation

3.1.5 Methodology of fish meat ball preparation

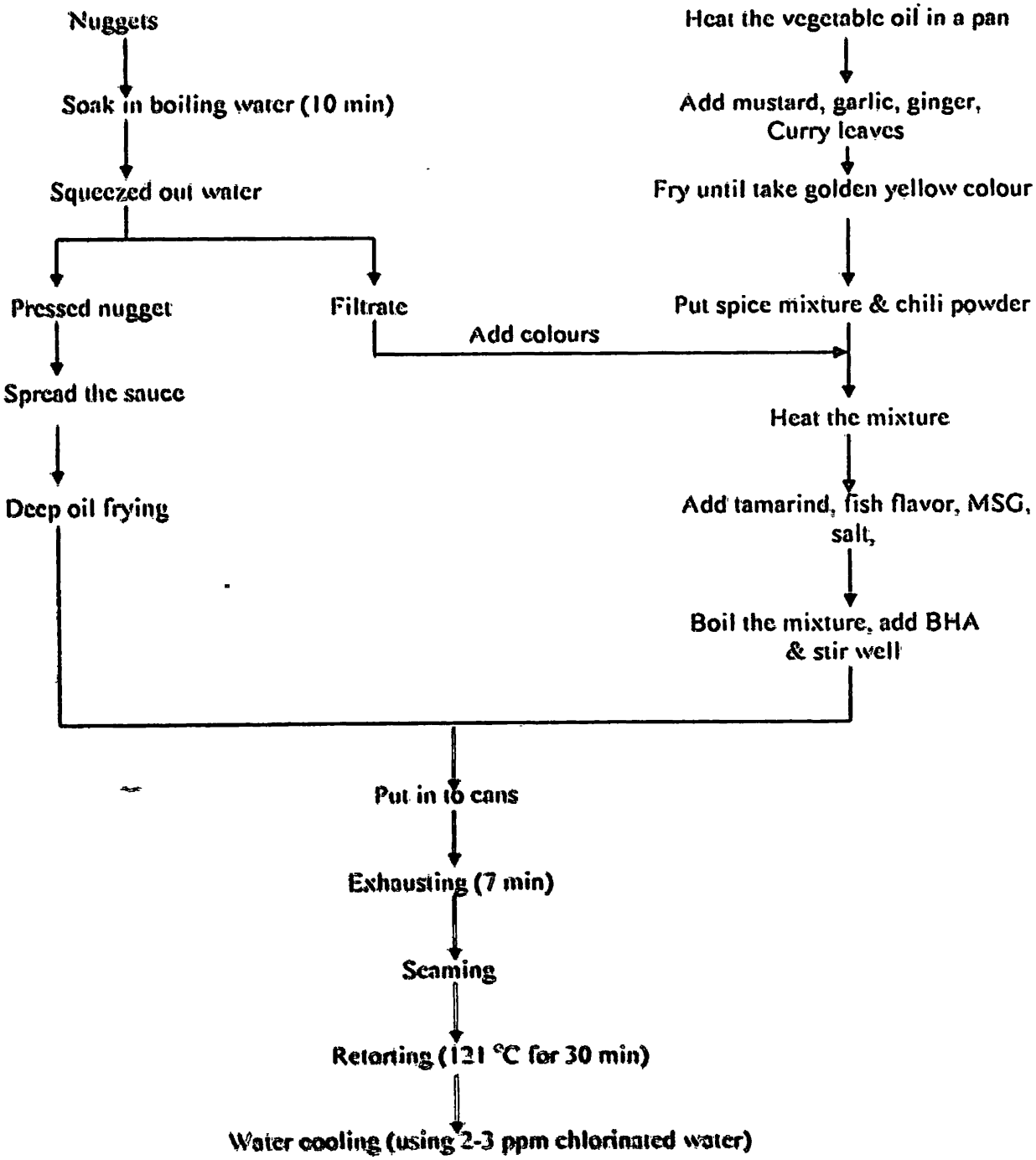

Fig: 3.3. Flow chart of the fish meat ball preparation

3.1.6. Ingredients for formulation and development of devilled chicken flavor soya meat ball

Vegetable oil

Chili pieces

Fried garlic

Fried B'onion

Chili powder

Corn flour

Pepper

Chicken flavor

MSG

Nugget washed water

Salt

Sugar

Na-Benzoate

Tomato sauce

Soya sauce

Oyster sauce

Red orange color

BHA

Soya nugget

3.1.7 Methodology of devilled chicken meat ball preparation

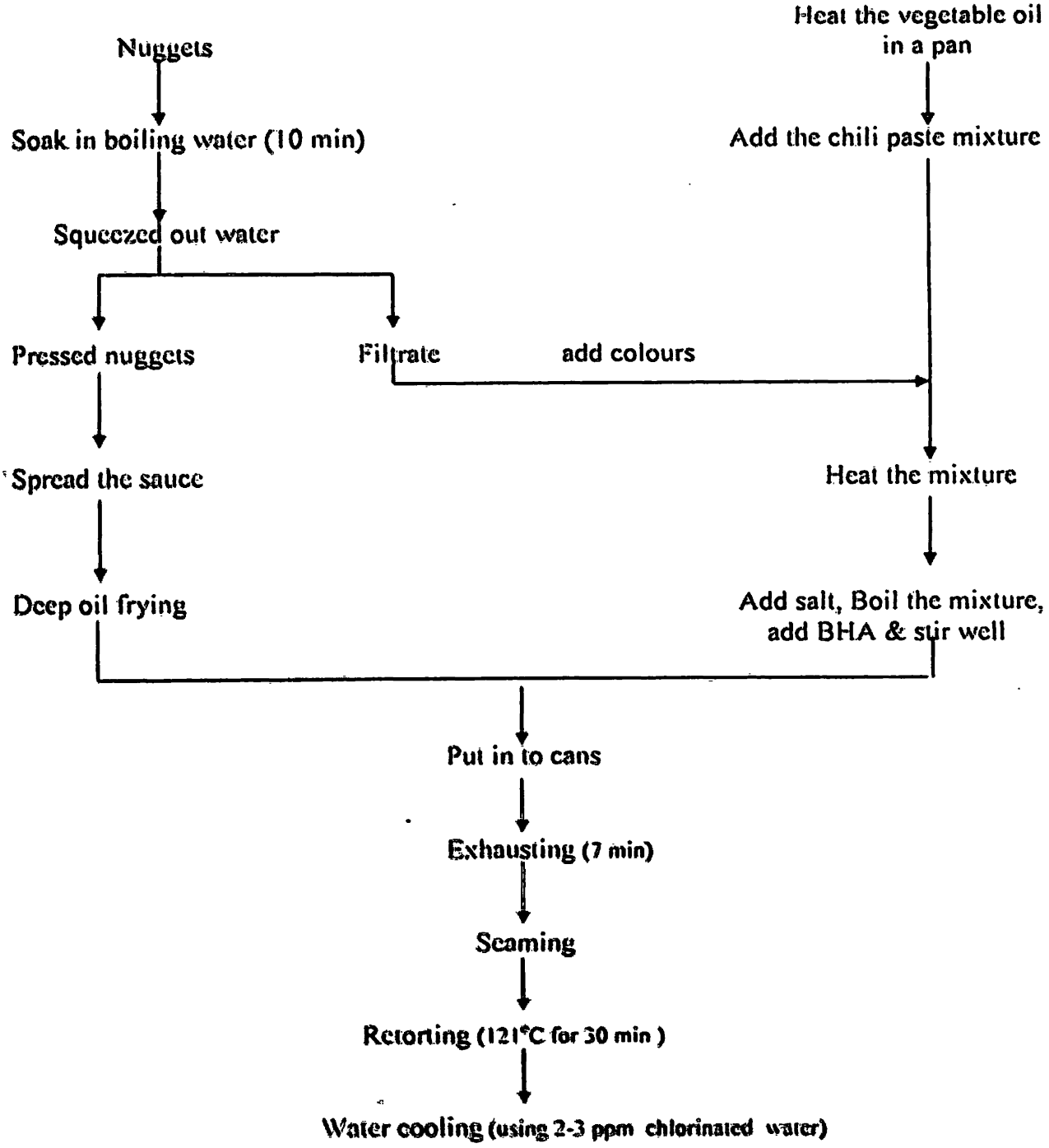

Fig :3.4. Flow chart of the devilled chicken meat ball preparation

3.1.8 Ingredients for soya meat ball nugget

Ingredients of spice mixer	Other ingredients
Coriander	Soya flour (sonic)
Cumin	Pepper
Fennel	Chili powder
Cardamom	Corn flour
Clove	Salt
Garlic	MSG
Ginger	Isolated soya protein
Metty seeds	
Curry leaves	
Saera	
Cinnamon	
Rampe	

3.1.9 Methodology of meat ball nugget preparation

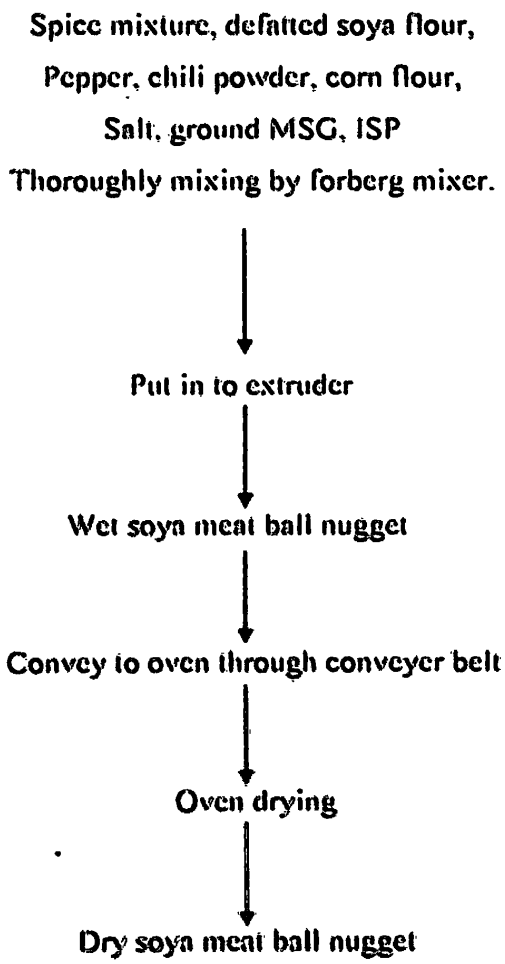

Fig: 3.5. Flow chart of the meat ball nugget preparation

3.2 Apparatus

3.2.1. Apparatus for formulation and development of soya meat nugget.

- Extrusion machine
- Flour mixing machine
- Digital scale (max 10 Kg & 1kg)
- Spice grinding machine
- Hot air oven

3.2.2. Apparatus for the formulation and development of meat ball curry

- Digital scale
- Gas cooker & cylinder
- Frying pans & spoons
- Stainless steel saucepans
- Kitchen table
- Chopping boards
- Knives
- Baskets with lids
- Sievers

3.2.3. Apparatus for the canning process

- A1 SR can
- Two roller Can seaming machine
- Retorting machine
- Water tank or sink
- Steam supply system

3.2.4. Materials for Sensory Evaluation

- Sensory evaluation ballet paper
- Coded, canned meat balls curry currently exist in market and newly developed sample
- Serviette
- Glasses of portable water
- Fork and spoon

3.2.5. Materials for determination of seal integrity, pH and Temperature

- Pincer
- Canned opener
- Venire caliper
- Platinum electrode pH meter
- Glass thermometer
- IR thermometer

3.3. Micro biological test methods

To determine the sterility of the product, micro biological tests were done according to act of SLS 516 part 10 1983.

Commercial sterility means

The condition achieved by application of heat which renders food free of

a. Micro –Organisms capable of growing in and spoiling the foods.
b. Pathogenic micro-organism capable of proliferating in the food under normal condition of storage and distribution

Sterilization /retorting condition

a. In oven at 170 -175 °C for not less than 1 hour.
b. In auto clave at 121 ± 1 °C for not less than 20 min .

Here cans were sterilized at 121 °C for 30 min under 1.5 bar pressure.

Micro-biological testing procedures were done as follows

Culture media and Dilution fluid

1) Tryptone broth media

Composition

Dripstone or trypticase	10 g
Glucose	5.0 g
Dipotassium hydrogen phosphate (K_2HPO_4)	1.25 g
Yeast extracts	1.0 g
2% alcoholic solution of bromo cresol purple	2 .0 g
Water	1000 ml

3.3.1. Preparation of media

- All the components were Dissolved in 1000 ml water with gentle heat and Dispensed 10 ml portions in to 20mm × 150mm screw – cap test tubes.
- Then tubes were Auto calved for 20 min at 121°C.

Other media that can be used for low-acid foods

1) Cooked meat medium
2) Liver broth
3) Nutrient agar

Procedure:

Incubation

Cans were Incubated at 30 °C to 35 °C for 10 days for low acid foods.

3.3.2. Preparation of test samples

Followings are the steps should be followed when preparation of samples according to act of SLS 516 part 10.

- Tests should be conduct in a clean room. (If necessary open room may be used but outside windows must be closed and direct draughts across work area must be eliminated). If available use laminar flow cabinet.
- Remove labels from containers and record details on the label, codes, and any evidence of physical damages, particularly to the side and double seams in the case of cans

  (If any of the selected containers show obvious defects due to poor handling during transport, storage, and distribution discard them and replace with containers from the lot.)

- In case of cans, proceed as follows;
  1. Washed cans with soap and water and dry with clean paper towels
  2. Wipe table top with 100ppm Cl_2 solution immediately before placing washed and dried can on it.

3. Place code end of the can in down position and number cans in ink or with $CuSo_4$ marking solution to right of side seam.
4. Completely covers hair with clean cap, washed hands with soap and water.
5. Flood the non-coded end with 70% alcohol pour off excess. play the flame of a Bunsen burner down to the end of the can continuing until the visible moisture film evaporates.
   (if the can swells, keep the side seam directing away from the analyst and flame cautiously)
   Cover the can immediately with a sterile Petridis lid.
6. Clean can opener with 70% alcohol and flame the metal portion. Aseptically cut and remove a disc from the non – coded end.

- Immediately remove 2g of food using a sterile cork borer and transfer to each of two tubes of aerobic and two tubes of anacrobic media
- Remove additional 25 g of food aseptically, using a sterile spatula and place in sterile closed containers. Refrigerate at 4 °C for latter testing if necessary.
- Incubate tubes at 30 °C to 35 °C for 72 hrs and examine.
- Subculture tubes showing growth on to plating media and examine.

Note: sub culturing is rarely done on a routing basis because it is time consuming expensive and runs a risk of laboratory contamination which could lead to faulty interpretation. This procedure is neecssary only when the results obtain in Naked eye & microscopic examination, and pH determination are inconclusive.

- **Contamination control**

As a control experiment, to control the contaminations a tube of nutrient agar (without inoculate the with sample) was exposed on a table for an equal time to the longest duration that inoculated tubes were exposed and incubated at 30 – 35 °C and microbial growth on the control tube was examined daily for three days.

- **Typical and microscopic examination.**

  - Odor and typical appearance of the contents were examined and recorded.
  - Incubated samples were examined microscopically under oil immersion heat fixed smears of food, stained with 1% gentian (or crystal violet) and washed in running water, and examined wet mounts with phase contrast microscope.

    Note:

    If food contains appreciable fat xylol should be dripped across the food smear while it is still hot from heat fixing. And then compare stained smear with one made from normal products if available.

3.3.3 pH Determination

pH variation of the food sample was determined, by considering the initial pH of the food as the reference.

Both reference pH and the sample pH were Recorded and compared with a typical can.

3.3.4 Confirmation

Although microbial growth is recorded from a container of food, if there is no any evidence of spoilage, following procedure should be carried out to confirm the sterility of product.

1) Grow the bacterial isolate or isolates on pure culture.
2) Select an unopened container of food exhibiting the same manufacturers code as the one previously tested.
3) Using aseptic techniques make a small puncture hole through the container.
4) Inoculate the product under its surface with the microbial isolate.
5) Seal the apparatus of the container aseptically. In case of cans' flames the puncture hole to create a vacuum in the head space, and aseptically seal with solder on similar material.
6) Incubate the inoculated container at 30 °C to 35 °C for 10 days.
7) Open the container and examine the product.

3.3.5 Interpretation of result

Commercial non-sterility

When direct smears reveal excessive micro-organisms and one or more product characteristics that obtain from the typical & microscopic examination, and pH determination are abnormal, the product is considered as commercially non sterile.

When the results of microscopic examination, and pH determination are inconclusive, check on the results of subculture. The product is consider commercially non sterile.

a) When both the tubes in the duplicate set showed growth with similar microbial flora and which in turn is similar to that in the original product and
b) When the confirmation procedure showed that the spoilage indices were identical for both containers.

Commercial sterility

If the product appears as normal in typical and microscopic examination it revealed that there is no excessive micro – organisms in the product and it is considered as product is commercially sterile.
If the results of typical & microscopic examination and pH determination are Inconclusive the results of sub-cultures are considered. The product is considered as commercially sterile under following conditions.

a) When all the subcultures show no growth
b) When only one of the tubes in the duplicate set showed growth, the microbial flora of which is not similar to that seen in the original product
c) When both the tube in the duplicate set showed growth, the microbial flora of which are not similar to each other and/or not similar to that in the original product and the conformation procedure showed an obvious spoilt product

3.4 Determination of Container seal integrity

Containers should hermetically seal to avoid contamination, specially during cooling of the cans. Here double seaming technology is used. The hermetic seal formed between the can body and can end is known as double seaming. That process is consists with three steps.

1. Body hooks butting (primary seal formation)
2. Actual overlap (secondary seal formation)
3. Tightness rating (ensuring the seam is held under sufficient compression)

To ensure the can sealing integrity, following can attributes were measured using venire caliper.

1. Seam length
2. Body hook
3. Cover hook
4. Actual overlap = (Seam length + Body hook + EPT*) – Seam length
5. Overlap % = $\frac{\text{Actual overlap}}{\text{Seam length} - (\text{EPT}^* \times 2 + \text{BPT}^{\#})}$

* End Plate Thickness

Body Plate Thickness

3.5 Determination of changes of physical characteristics of the food

To determine the physical quality changes of the canned products, it was incubated at 37°C and examined the physical changes weekly such as appearance, color, odor, texture, taste

3.6 Determination of pH changes of the food

The variation of pH with time was measured weekly by using calibrated platinum electrode pH meter.

3.7 Evaluation of Sensory appeal to determine the best sample Characteristics (Color, Aroma Texture, Taste, and Overall acceptability)

The sensory evaluation was done by 30 untrained panelists of Raigam marketing services (pvt) ltd. Acceptability of 2 samples (market sample and newly developed one) was evaluated using 9 – point hedonics scale subjectively. Two samples were coded as three digits number. Coded samples, ballot papers and water glasses were given for each and every panelist. Results were analyzed using computer aided MINITAB Statistical Analysis package according to Friedman test (Bluman, 2001). Once samples are seemed to have a statistically significant difference, median and sum of ranks were calculated separately for those attribute, in order to determine the degree of difference and to select the best sample. After treating the data in such a manner outcomes could be able to summarize. (See table 4.5)

CHAPTOR 04

RESULTS AND DISCUSSION

4.1. Nugget preparation

In Raigam marketing services, mainly they use three brands of defatted soya flour. Such as Ruchi, Sonic and Vippy. The specifications of these three types are varying from each to each from nutritional composition, moisture content, particle size..... etc.

Table: 4.1 specification of soya flour

	Ruchi	Sonic	Vippy
Protein %	Min 52	Approx 52	52.4
Fat/oil %	Max 1	1	0.96
Fibre %	Max 3.5	2.8 – 3.1	2.94
Ash %	6.2 6.5	6	-
Moisture %	Max 8%	6.5 – 7.5	6.96
NSI %	60 – 65	-	66.46
PDI %	-	-	72.11
Particle size	95 % passing through 100 mesh	90% passing through 200 mesh	96.9% passing through 100 mesh

The composition of the soya flour plays an important role in nugget formation. Therefore when formulate the soya nugget, particle size of the soya flour is directly affected to final quality of the nugget. Nuggets formulated from the sonic flour were better than other two types.

As well as it is a special type of nugget. Because mixture of spices, salt, MSG, chili and pepper have added to the soya flour mixture. These additives impair the natural binding ability of the soya protein. And since it is somewhat larger than other regular nuggets, special types of binders were used to keep the shape of the nugget. Such as xanthan gum, corn starch and Isolated soya protein (ISP).

Nuggets could not formulate by only using corn starch and final quality of the nuggets which were produce from using xanthan gum was not good. It was so tough texture.

Nuggets which were produced by using combination of ISP and corn starch were better than others. ISP is very expensive than other two types of binders. Therfore to reduce the production cost some amount of corn starch was added as a substitute for ISP.

To obtain the desirable size and shape new cutter die was developed.

The unfavorable beany flavor is an another problem of soya flour and to mask the beany flavor, specially produced spice mixture, chili powder, ground pepper, salt, ground MSG, were added in to the flour mixture.

4.2. Curry preparation

Each type of curries were prepared according to its recepies,. When cooking curries and nuggets considerable amount of vegetable oil is used. Therefore it may be readily susceptible to reactions of fat oxidation. To prevent the oxidation of fat, suitable type of anti – oxidant should be used. BHA has listed as common preservatives considered generally recognized as safe (GRAS) and its anti oxidation property prevent or reduce the fat oxidation in canned products. GRAS regulations limit BHA to 0.02 percent or 200 parts per million (ppm) of the fat or oil content of the food product. Antioxidant suppress the reaction that occurs when foods combine with oxygen in the presence of light, heat and some metals and also minimize the damage to some essential amino acids And loss of some vitamins.

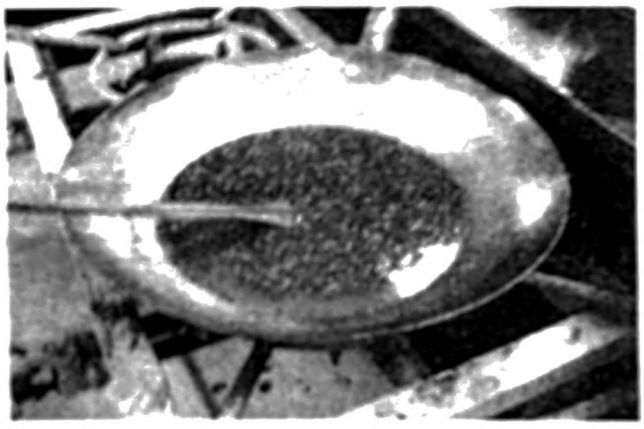

Fig: 4.1 curry preparation

4.3. Canning process

Selection of canning material

Some important points should be considered in selection of suitable can type are;

- Initial pH, and pH variation with time of the food that expect to pack in the can
- Sulfur contain of the food material that expect to pack in the can
- Retorting conditions i.e. temperature, pressure, heat medium
- Expected shelf life
- Size and volume of the can
- Price of the can etc

The pH of the newly developed products varied from pH 5.1 -5.7, all of these four products belong to low acid foods. Therefore sulfur resistant can was selected and It is tolerate to low acid (from pH 3.5 – 6.5) as well as it is resistant to sulfur staining.
When concern thus about the size of the can, size vary from grade A1 to A10. A1 is smallest one and A10 is the largest one. Since A1 size, can afford about 450-475 g of the food product, A1 size was selected to packing the food.

Cleaning the can

Empty cans and lids were dipped in 0.5 % SMS added hot water for few minutes and drained out the water.

Can filling

Thirty numbers of fried nuggets were put in to the can and then curry was added up to total weight equal to 470 g. appropriate head space (about ¼ inch) was provided to prevent the bloating.

Exhausting

To remove the trapped air, cans were exhausted for seven minutes using a retortor before Seam the can.

Can seaming

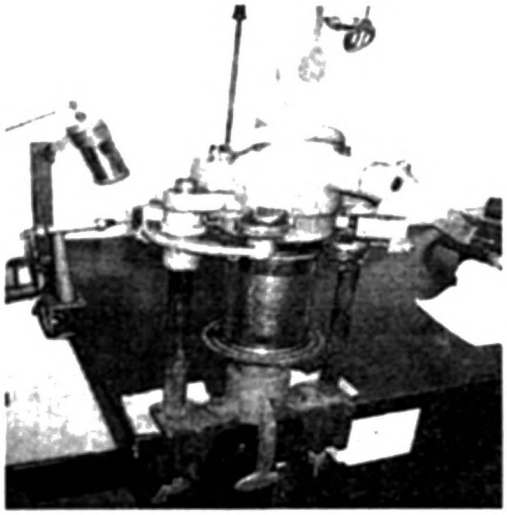

Fig: 4.2 can seaming

Two roller and four roller seamers are mostly used in food canning in food industries. Other than that single roller seamers are also available in the market, but it does not used in food industry. Because of, the seal integrity is relatively high in two or four roller seamers than single roller.

Seam integrity was determined by measuring can attributes such as;

1. Seam length
2. Body hook
3. Cover hook
4. Actual overlap = (Seam length + Body hook + EPT*) – Seam length
5. Overlap % = $\frac{\text{Actual overlap}}{\text{Seam length} - (\text{EPT}^* \times 2 + \text{BPT}^{\#})}$

* End Plate Thickness

Body Plate Thickness

Table 4.2.Standard values of can attributes should exist to confirmation the seaming efficiency

Seam length	2.8 – 3.2 mm
Body hook	1.9 – 2.1 mm
Cover hook	1.73 – 2.05 mm
Actual overlap	1.02<
Overlap %	minimum 45%
EPT	0.21 mm
BPT	0.18 mm

As mentioned above seaming parameters were measured against the standards, and determined the seaming efficiency.

Table 4.3 practical value of can attributes

	1	2	3	4
Seam length	2.70	2.65	2.78	2.83
Body hook	2.00	1.95	1.88	1.91
Cover hook	1.75	1.82	1.73	1.88
Actual overlap	1.11	1.03	1.12	1.16
Overlap %	52	50.4	55.2	59.1

Retorting

After exhausting process cans were sterilized by applying various time and temperature combinations.

Fig:4.3 retorting

Table 4.4 determination of F- value

Treatment	Observation
1. At 121 °C for 20 min	Cans were bloated
2. At 121 °C for 30 min	No any undesirable physical changes
3. At 121 °C for 40 min	Product become roasted flavor

Retorting time calculation was started after the temperature reached to 121 °C under 1.5 bar pressure.

According to above observation second treatment was selected to sterilize the product.

4.4. Cooling of cans

Sterilized - cans were immediately cooled by using 5 ppm chlorinated water. The spoilage in water cooled cans has been shown to be about 10% greater than that in air – cooled cans. The water used for cooling cans should be free from pathogenic bacteria. Total viable plate counts should not greater than 100 per ml. At this level one drop (0.05 ml) of water would contain five micro-organisms. The entry of one fifth of a drop (1 organism) is adequate to cause the spoilage. If the counts were to be 10^6 bacteria per ml, the can seams would have to protect against the entrance of as little as 1/50000 th of a drop of water to prevent recontamination. This level of seam perfection is near impossible to achieve under commercial conditions.

Therefore water should contain at least 2-3 ppm of residual available chlorine. Cooling water containing 10 ppm of available chlorine gives better result. But it may be cause to external corrosion.

4.5. Micro-biological testing

Any microbial growth was not recorded in the food inoculated tubes that are incubated at the 30 -35 °C for 10 days. That was mean; the selected heat treatment combination was sufficient to kill all microbes and there spores present in the can. On the contrary that is means that the product is commercially sterile.

4.6. Determination of physical changes of the can content

Cans were incubated at 37 °C and examined the Changes of Physical properties of the food products weekly. such as appearance, color, odor, texture, taste. There were no any remarkable changes in physical characters from end of the November of last year to end of the January.

4.7. pH changes

Changing of pH with the time was measured weekly and collected data can be illustrated graphically as below.

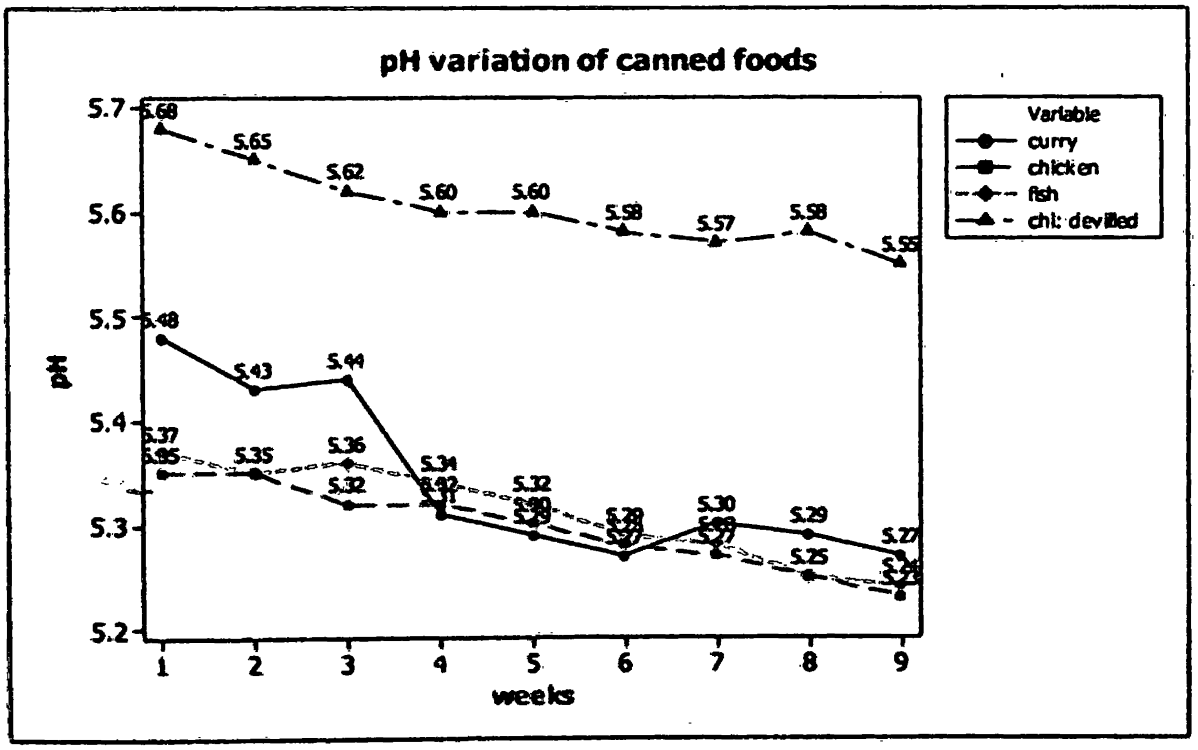

Fig: 4.4 pH variation of canned foods

Since there was no big pH variation with the time in any product according to the illustration, we could guess that micro biological and enzymes activity is no or minimum in final products.

4.8. Results of sensory evaluation

Records got from Friedman test were summarized as follow.

Table :4.5 values of sensory data

Sensory Attribute	P-Value	Sum of Ranks		Median		Best Sample
		348	635	348	635	
Color	0.006	52.5	37.5	7.500	6.500	348
Aroma	0.000	60	30	7.500	6.500	348
Texture	0.144	49	41	8.000	7.000	====
Taste	0.000	55	35	8.250	6.250	348
Overall Acceptability	0.000	60	30	8.000	6.000	348

348 – Newly developed chicken flavor sample

635 – Market sample

By considering p-Value and comparing the sum of ranks of each attributes, best sample was selected under 95% confidence level.

Evaluation of sensory result to determine the degree of preference of two samples.

Color

P - Value of the color attribute was 0.006. it was lesser than the value of α (0.05). it reveals that there is sufficient evidence to reject null hypothesis and there is a difference between color the two samples. By comparing the sum of ranks of each sample, highest median posses to 348. According to that color of the 348 sample was best. (See app II)

Aroma

P – value (0.000) indicates that there are sufficient evidence to reject null hypothesis and there is difference between aroma of the two samples. As well as the higher median of the 348 implies that aromatic properties are best in the 348 than 635. (See app II)

Texture

P –value of the texture attribute 0.144 was greater than α. So there is no sufficient evidence to reject null hypothesis and its mean there is no difference between the texture of two products. (See app II)

Taste

Preference for taste of the two samples was difference according to the value of the P table (0.000). it is less than α and according to sum of ranks of two products the best taste was the 348. (See app II)

Overall acceptability

P – value for the preference of overall acceptability was 0.000 provides sufficient evidence to reject null hypothesis and it indicates that there is a difference between the overall acceptability Of two samples. The value of sum of ranks of 348 sample was 8.00 and it is less than the value of 635. It revealed that 348 was the most preference sample. (See app II)

4.9. Product costing and marketing survey

Product costing was done for the each four type of products. Cost of production of each four types of products lies around 90.00 rupees and wholesale price was 115.50 rupees and maximum retail price was 130.00 rupees. (see app IV)

A marketing research was done to search the consumer acceptability to a meat free meat ball like product, and to collect information about the related canned products that currently available in the market. Depends on the data collecting through the marketing managers of Raigam marketing services (pvt) ltd that widely spreaded throughout the Sri Lanka, there would be demand for 75,000 cans per month .

Marketing information of the canned meat ball products currently available in the market

Table 4.6 results of marketing survey

Product	Retail price (Rs)	Wholesale price (Rs)	Free issue (No:)	Nt weight (grms)	Drained weight (grms)	Average monthly demand (no:)
Market sample No :01	189.00	179.00	1 for 24 cans	400	240	75000-85000
Market sample No:02(un cooked)	135.00	121.50	1 for 24 cans	390	250	84000
Market sample No:03 (pre cooked)	165.00	147.00	1 for 24 cans	390	250	

CHAPTER 05

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The prepared ready to eat extruded textured soya products have good consumer acceptability than other related canned products that currently available in the market.

This is a good solution for the protein and essential amino acid requirement for the vegetarians and others. As well as due to the reasonable price and low time consuming to preparation, it can be purchase, to not only rich society but also other people and it is good solution for the people those who are struggling with the time in their life.

The F value of the process is 121°C for 30 minute is ideal, according to the result of the commercial sterility test. Test result revealed that product was commercially steriled under this time temperature combination up to three months.(but further shelf study should be done).

The four types of products not have shown the considerable variation of pH value with time. Therefore undesirable reactions with caning materials cannot expect.

According to the result of commercial sterility test, product had been low microbiological load. Therefore this product can be kept for long time under the normal environmental condition without changing of nutritional and physical properties.

5.2 Recommendation

The proximate analysis for nutritional attributes should be done to evaluate the nutritional composition of the product.

A Shelf life study should be done at least for 12 months to determine the physical and chemical changes during the storaging time

Should be selected the cost effective packaging material to reduce the production cost.

The hygienic condition of the production process line and the workers those who involve to the product manufacturing process should be in optimum level.

Sterilization facilities, cleanliness of equipment and utensils, good ventilation systems, fully insulated steam systems that used for production should be maintained properly.

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Appendix 1

SABARAGAMUWA UNIVERSITY OF SRI LNKA

Department of Food Science & Technology

Ballot sheet for the comparison of soya meat ball and general meat ball.

Name: - ..... Date: -.....

Please evaluate sample for characters given below and indicate your acceptability for each sample using scoring scale.

Batter seasoning for Meat base Product

1. Extremely Dissatisfied
2. Very much Dissatisfied
3. Moderately Dissatisfied
4. Slightly Dissatisfied
5. Neither Satisfied nor Dissatisfied
6. Slightly Satisfied
7. Moderately Satisfied
8. Very much Satisfied
9. Extremely Satisfied

Sample code / characteristics	348	635
Color		
Aroma		
Texture		
Taste		
Overall Acceptability		

Your comments

.....

.....

Thank you.

Appendix II

Color of the 348 and 635 samples

Test hypothesis

H0: h1 = h2 versus H1: h1 ≠ h2 , where h is the median of color of the samples.

h1 is median of 348 and h2 is median of 635

Friedman Test: color versus treatment blocked by assessors

```
S = 7.50  DF = 1  P = 0.006
S = 7.76  DF = 1  P = 0.005 (adjusted for ties)

                              Sum
                               of
Treatment    N  Est Median  Ranks
348         30      7.5000   52.5
635         30      6.5000   37.5

Grand median = 7.0000
```

Decision rule: Reject H_0 if p value < α

Decision: P value,(0.006) is less than α (0.05). H_0 rejected. Thus, there is a difference between color of two samples

Aroma of the 348 and 635 samples

Test hypothesis

H0: h1 = h2 versus H1: h1 ≠ h2 , where h is the median of aroma of the samples.

h1 is median of 348 and h2 is median of 635

Friedman Test: Aroma versus treatment blocked by assessors

```
S = 30.00  DF = 1  P = 0.000

                              Sum
                      Est      of
Treatment    N  Median  Ranks
348         30   7.500   60.0
635         30   5.500   30.0

Grand median = 6.500
```

Decision rule: Reject H_0 if p value < α

Decision: P value,(0.006) is less than α (0.05). H_0 rejected. Thus, two samples are deferent in aroma

Texture of the 348 and 635 samples

Test hypothesis

H0: h1 = h2 versus H1: h1 ≠ h2 , where h is the median of texture of the samples.

h1 is median of 348 and h2 is median of 635

Friedman Test: texture versus treatment blocked by assessors

```
S = 2.13  DF = 1  P = 0.144

                                Sum
                                 of
treatment    N  Est Median    Ranks
348         30      8.0000    49.0
635         30      7.0000    41.0

Grand median = 7.5000
```

Decision rule: Reject H_0 if p value < α

Decision: P value,(0.144) is higher than α (0.05). no sufficient evidence to reject H_0 . Thus, two samples are not deferent in texture.

Taste of the 348 and 635 samples

Test hypothesis

H0: h1 = h2 versus H1: h1 ≠ h2 , where h is the median of taste of the samples.

h1 is median of 348 and h2 is median of 635

Friedman Test: taste versus treatment blocked by assessor

```
S = 13.33  DF = 1  P = 0.000

                          Sum
                Est        of
treatment   N  Median    Ranks
348        30   8.250    55.0
635        30   6.250    35.0

Grand median = 7.250
```

Decision rule: Reject H_0 if p value < α

Decision: P value,(0.000) is less than α (0.05). H_0 is rejected . Thus, two samples are deferent in taste.

Overall acceptability of the 348 and 635 samples

Test hypothesis

H0: h1 = h2 versus H1: h1 ≠ h2 , where h is the median of overall acceptability of the samples.

h1 is median of 348 and h2 is median of 635

Friedman Test: overall acceptability versus treatment blocked by assessor

S = 30.00 DF = 1 P = 0.000

Treatment	N	Est Median	Sum of Ranks
348	30	8.000	60.0
635	30	6.000	30.0

Grand median = 7.000

Decision rule: Reject H_0 if p value < α

Decision: P value (0.000) is less than α (0.05). H_0 is rejected . Thus, two samples are deferent in overall acceptability

... Continuation Sheet

APPENDIX III

TEST REPORT

Report No. SS 12420

Customer: [illegible] Services [illegible] Ltd [illegible] Kanjikode [illegible]	Test Item: **CANNED PRODUCTS** Service Requested: Customer's request dated 13th October 2008
Description: [illegible] of canned products (approx 180g each) in coated metal cans	Identification of Test Item: Label 1. CD 2. CURRY Date of Receipt of Test Item: 25th November 2008

Test Dates: 26th November 2008 to 11th December 2008

TEST PERFORMED

Test Performed	Method	Result
Physical appearance of the container	SLS 516 : Part 10. 1983	Did not show any bloating or leakage in the container
Physical appearance of the content		Showed the normal odour and appearance of the products
[illegible]		Commercially sterile

SLS 516 : Part 10. 1983 Sri Lanka Standards Specification for Microbiological test methods
Part 10 Commercial sterility of low acid and acid canned foods

Analysis was carried out by Ms. P. L. S. Kumari, Technical Assistant.

[illegible]
[illegible]

[illegible]
[illegible]

Appendix IV costing report

		Curry	Fish	Chicken	D/Chicken
Reatail Price		130	130	130	130
Wholesale Price		115	115.5	115.5	115.5
Discount	11.15%	12.82	12.88	12.88	12.88
wholesale After Discount		102.18	102.62	102.62	102.62
VAT Adjusted Wholesale Price		83.18	91.63	91.63	91.63
Direct Materail Cost					
Raw material		22.65	26.47	36.42	24.88
Packing Material		30	30	30	30
Direct Labour Cost		1.08	1.08	1.08	1.08
Direct Over head					
Electricity		0.05	0.05	0.05	0.05
Contribution		29.4	35.08	34.08	36.17
Indirect Overhead					
Admin. Overhead					
Depreciation		0.08	0.08	0.08	0.08
Others	3%	3.47	3.47	3.47	3.47
Distribution overhead	10%	11.55	11.55	11.55	11.55
Net Profit		22.42	19.99	18.98	21.07
Net Profit as a % of W/S Price		14.07%	19.46%	18.50%	20.55%
Trade margin		13.04%	12.55%	12.55%	12.55%

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