FORMULATION OF AN INSTANT VEGETABLE SOUP AND EVALUATION OF SHELF-LIFE

By

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DECLARATION

I hereby declare that the work reported in the project report was exclusively carried out by me, under the supervision of Mr. K.K. Kithsiri and Mr. M.A.J. Wanshapala. Any part of this project report has not been submitted earlier or concurrently for same or any another degree.

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AFFECTIONATELY DEDICATED TO

MY EVER LOVING PARENTS AND SISTERS

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ABSTRACT

Soup is nutritious and flavourful food item, which is, consumed prior a meal. It stimulates appetite of consumer. Soups are specially suitable for children, elderly people and patients.

Preparation of nutritionally rich soup is a time-consuming task. Therefore processed soups are becoming popular among the people those who are tired with day today activities. There are three types of processed soups available in foreign markets that are dehydrated soups, canned soups and frozen soups. Dehydrated vegetable soups are manufactured in two ways. The first is dry soup mixes, which are made by using dehydrated vegetables, and the other is dehydrated instant soup, which are made by using fresh pulp of vegetables.

The main steps involved in instant dry soup manufacturing are preparation of soup according to developed formula, blending into a puree, drying into powder form by a drum drier. Hence, the heat sensitive vitamin like vitamin B and C that present in freshly prepared soups are destroyed during the drying process fortification is essential. The product is also rich in other vitamins, proteins, carbohydrates, fats, minerals and fibres.

The moisture content of dehydrated soups is in the range 2-3% and it should not exceed 7% during the shelf life. Water activity should below 0.6 to avoid microbial deterioration. Studies of the estimation of shelf life of such dehydrated products was based on physical changes which are caused mainly due to the moisture content of the product. The packages, which are resistant to moisture and light can be used as protective coverage for these products and thereby extent the shelf life of the product. It has been found that Aluminium foil laminated packs are the most suitable package for dehydrated soups. In this study metalized polyethene , which can not act as a complete barrier to oxygen and light was used as the package.

Storage-life of dehydrated soup at ambient temperature is longer than canned and frozen soups. Therefore there is an increasing demand for them in foreign market. Higher consumer acceptability of soup, nutritive value and low cost are the major reasons that the popularity among majority of people.

During the study it was found that there was no post fecal contamination in the product and rancidity after four months in storage life. Sensory evaluation proved that there is no significance different of consumer acceptability of the product when comparing with instant soup cubes that are available in local market. Slight changes in colour and aroma was occurred due to inability of package to avoid oxygen and light completely. However the product has passed successfully four months of storage life.

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CHAPTER 1
INTRODUCTION

Soup is an important part of a good meal, which can be served as either a snack or more often as a first course on a menu in order to stimulate the appetite. A good soup should be light and flavoursome, capturing various flavours and aromas of the chosen ingredients.

In our modern age home made soups have been increasingly replaced by commercially processed soups because of preparation of a nutritious, rich soup is a time consuming process. Commercially presented soups are in three forms such as, canned, dehydrated and frozen (Luh *et al.*,1975).

Dehydrated soups have an increasing demand in hospitals, governmental institutions, the hotel and restaurant trade, and in Armed Forces in foreign market. They have several advantages over canned soups: long storage life at ambient temperature and no need refrigeration, low transportation cost due to their lightweight per unit portion and easy reconstitution (Luh *et al.* 1958).

There is no an instant vegetable soup in powder form in local market and smearing is not required for this type soups, just dissolve in hot water and consume. One of the dehydrated soup processing method that preparation of a complete soup according to a developed formula, cook and blend into a puree and dehydrated on roller driers or drum driers is used to produce instant soups. High quality soup can be obtained by this method (Luh *et al.*,1975).

Developing of soup formula is a huge task that technical skills are required. Ingredients that make the body of soup act as preservatives, flavour enhancers and their standard quantities should be on this study. Formula developed by food scientist can be aided for developing a new formula (V. Arsdel *et al.*1973). It is very important that the temperature on drier and time of dehydration carried out for complete dehydration.

Packaging soon after dehydration process is very important because after the dehydration process moisture content of the product is nearly 2% so, immediately absorbs moisture from atmosphere and affects shelf life of final product. Package should act as a barrier to moisture, Oxygen and light permeability because these factors govern chemical deterioration during storage. Filling into the package as a little air space as possible, or with an inert gas or vacuum packing are practiced during packaging process (Labuza, 1977). It has been found that aluminium foil laminated packs are ideal for dehydrated soups (Luh *et al.*,1958).

OBJECTIVES

1. Production of a dehydrated instant vegetable soup
2. Determination of its shelf-life

CHAPTER 2
REWIEW OF LITRATURE

2.1.Formulation of Dehydrated Soups

There are four major studies should be carried out in the formulation of dehydrated soups.

1.Formulation development
2.Taste testing
3.Storage studies
4.Acceptance studies

2.1.1.Formulation development

Companies approach the development of formulas for dried soups in two different ways.

1. The matter is put in the hands of the food technologist who has a scientific background especially in food processing, a keen appreciation and broad knowledge of the availability, limitations and potential usefulness of various food substances utilized in soup formulas.

2. The other is that the formulation is put into the hands of persons who knowledgeable in consumer preferences and kitchen practices, because acceptance by the house wife is of paramount importance to the success of any formula in the retail market. The requirements are fitted by the home economist trained in nutrition and food preparation, and experienced in dietetic and restaurant feeding.

Her approach to a soup mix formulation generally consists of the preparation of what she considers to be highly acceptable kitchen-prepared soup. When once it is reached to optimal flavour, consistency, and appearance, dry ingredients are combined and reconstituted with water by the home economist until closely matching with the soup prepared from fresh ingredients.

Probably it can be ensured to most successful, the combination of both home economist's experience and the knowledge and skill of the food technologist. In many instances, a food engineer is needed in the development team in order to prove the necessary or desirable to make small scale batches of ingredients, partial formulations, or complete formulations with pilot plant equipment.

2.1.2.Taste Testing

Taste panels are required in the successful development of dry soup mix formulations. Identifying flavours and other qualities during the early stages is done by a small group of experts. The triangular cup test is carried out in order to distinguishing such differences. This test is one of the tests that are used to check a difference between samples. The other tests can be used are simple paired comparisons test, Scheffe paired comparisons test, duo-trio test, multiple comparisons test, ranking, scoring and ratio-scaling.

The next step, an evaluation of consumer acceptability is followed when an acceptable blend of ingredients has been satisfied the objectives of the formulation study.

2.1.3.Storage Studies

Storage studies should be initiated immediately in order to evaluate the shelf life or rate of deterioration of the formula under varying conditions. For this purpose, several different environments with controlled temperatures and humidity are required. Pre-determined routines of testing to observe differences traceable to deterioration must be established. Storage samples should be carried for up to two years, or until readily observed defects, such as off-flavour, or failure to rehydrate, become apparent. An accompanying study should be made of the reconstitution of the soup mix so that complete, adequate and easy to understand directions may be prepared. A study of the exact wording and listing of ingredients on the label is required by federal and state regulations.

2.1.4.Acceptance Studies

Nationwide consumer acceptance testing is the final stage of formulation studies. Such type studies are carried out on a comparison basis using a similar item in the retail market. This service is performed by market research organizations. A panel of 400 or 500 families is usually considered adequate for this type of testing. The management is provided a useful guide in deciding whether to proceed with taste testing of the new formula by the evaluation of the out come of such acceptance tests properly (Arsdel *et al.* 1973).

2.2.Dehydrated Soup Processing Methods

Dehydrated soups are processed commercially in major two ways. First, soup manufacturers purchase already dried and dehydrated ingredients, blending them according to a developed soup formula and packaging soups. They are called as dry soup mixes.

Second, formulating and cooking a complete soup, puree the soup, and dehydrating the puree on drum driers or spray towers. High quality soups can be obtained by this method.

Multi purpose food processing companies usually practice this method because of higher investment needs for drying equipment (Cruses 1948). Navy bean and green and yellow pea soups are produced using this method in U.S.A..

2.3.Drum Drier

Higher investment is required for drum driers in drying operation of dehydrated soup manufacturing. Drum driers are used for slurries or pastes in fine suspension, and also solutions. Milk, soup mixes, ingredients for baby foods, potato slurries and instant cereals are the examples of drum dried products.

Drum driers consist of hollow metal cylinders that rotate on horizontal axes and are heated internally by steam, hot water or other heating medium. There are three types, single drum, double drum and twin drums. Drums have to be carefully constructed into a perfectly cylindrical shape.

The most important aspect considered when using drum dryer is the uniform thickness of the film applied to the surface. This is in addition to the speed of rotation and heating temperatures. All of these affect the drying rate of a drum drier. The handling of heat sensitive materials while using drum driers requires the drums to be enclosed in a vacuum-tight chamber. The main advantages of drum drying are the high drying rates and economic use of heat. The main limitations of drum drying are the applied food has to be in a liquid or slurry form and it must withstand relatively high temperatures for short periods of time. The overall drying rate of the food film over the drum can be expressed as follows (Canovas *et al.* 1996):

$$\frac{dx}{dt} = \frac{F_s (x_o - x_f)}{t} = \frac{K_c A (T_w - T_e)}{\lambda}$$

x_f – Final moisture content

x_0 –Initial moisture content

F_s – The mass of solid in feed

T – Time

K_c – Overall heat transfer co-efficient

T_w –Temperature of the heated surface

T_e –The temperature of the evaporating surface

A –Surface area of the drum

λ –Latent heat at Te

2.4.Role of Ingredients

Many of the components of dry soup mixes are readily available through ordinary channels of supply. Such items as salt, sucrose, dextrose, corn syrup solids, corn starch, wheat starch, potato starch, hydrogenated vegetable fat, ground spices, dry skim milk, permitted colours, citric and tartaric acids, caramel, monosodium glutamate, beef extract, and like are quite standard and may be bought without particular specifications except as to moisture content and general good quality. On the other hand, there a number of ingredients, which exact specifications and careful testing, are required to insure the highest possible quality in the end product.

Thickeners – Suitable body or viscosity is an important factor in the acceptability of dehydrated soups. For this reason flour and starch play an important role. Corn starch and flour, potato starch and flour, wheat flour etc. are the important ones among them but corn starch is the most important.

Sugars – They are widely used in dehydrated soups. Sucrose, anhydrous dextrose, and corn syrup solids of low dextrose equivalent are the sugars commonly used. In any case sugar should be finely ground and, in the case of corn syrup solids, moisture content should be below 3%. Bulk is given by sugars without undue sweetness and is believed to contribute slightly to the viscosity of the soup upon reconstitution.

Fat - Among the fats used in dry soup mixes, chicken fat plays an important role. For this ingredient, strict specifications are essential and all purchased lots should be tested to insure compliance with specifications. Peroxide values should not exceed 2.0 and free fatty acid should be less than one per cent, while the moisture should not exceed 0.25 per cent.

Probably the hardened vegetable oils are most commonly used because of flexibility in physical properties, which they offer. When oxidative changes in the fats are found to cause a material reduction in the shelf life the dehydrated soup, it is possible to incorporate anti-oxidant in the fats prior to use.

Salt - Salt is another major ingredient used in dried soups. Its iron content should be below 5.p.p.m. and copper should be below 1 p.p.m. to minimize oxidative changes in the fatty component of the soup mix. The fineness of grind of salt may prove to be an important factor in the plasticity of mixtures of ingredients with fat, which are frequently combined into a paste. It requires experimentation on a production scale to settle on the precise degree of fineness desired. Federal standards permit the use of gallets, butylated hydroxyanisole (B.H.A), or butylated hydroxytoluene (B.H.T.). Total concentration allowed is limited to 0.02 per cent, based on the weight of the fat. The use of fats contributes richness of taste, pleasant flavour, and a desirable mouth feel.

Flavouring Materials – Among the flavour components universally found in dehydrated soups are monosodium glutamate (M.S.G.) and / or hydrolyzed animal and vegetable proteins or their mixtures.

M.S.G. - Other flavours are accentuated by M.S.G. but there is considerable difference of opinion as to whether this amino acid salt has a flavour of its own or serves merely to bring out or cover other flavours. Its general effect is a pleasant, somewhat salty, yet sweet and persistent stimulation of the taste buds. Some flavour experts hold that it has a flavour reminiscent of chicken. There is no doubt that this ingredient improves the flavour of almost any soup. Formerly M.S.G was obtained by the acid hydrolysis of wheat gluten, which contains over 25 % glutamic acid, or it was made from Steffens waste, which is a by-product of beet sugar manufacturing. It occurs in the anhydride form as glutamine.
In recent years, Japanese scientists have discovered a much less expensive method of making M.S.G. by bacterial conversion of low-cost sugars in deep vat fermentation, a process lesser costlier than acid hydrolysis.

Beef Extract – is a natural protein product, which makes an excellent base for soup mixes of the meat type due to its savory flavour. For ordinary retail trade, most manufacturers supplement or replace beef extract because of flavourings results from the acid hydrolysis of a wide range of animal or vegetable proteins. Neutralization yields a mixture of amino acids or their salts. The end product may be offered as a liquid, a paste, or a powder.

Autolyzed Yeast - is used to some extent in dehydrated soups. This is the result of enzymatic conversion of the proteins of brewer yeast at elevated temperatures, with subsequent inactivation. Dried debittered yeast and dried torula yeast are some times used. Various degrees of classification and filtration are used with the various hydrolysates before concentration and/ or drying. All of these proteins and protein-derived compounds are of material nutritional value in addition to their usefulness as sources of desirable flavour.

Vegetables – A wide variety of vegetables in various forms are used in dry soup mixes. The most common are carrots, potatoes, leeks, cabbage, onions, germ beans, tomatoes, celery, bell peppers, parsley, mushrooms and green peas.(Arsdel *et al.* 1973).

2.5. Packaging

Packaging of dried products is the next important step after drying operation. The selection of an appropriate packaging material plays an important role in storage stability of the product. Again the types of product, its composition, and physical properties have to be considered when selecting a packaging component.

Dehydrated soups require thorough protection from oxygen and moisture as well as from loss of volatile flavourings. As these products are often mixtures of ingredients, the requirements of the most sensitive components are of primary importance. Products with relatively high fat content must also be protected from light and oxygen and from interacting with the packaging material. Most of the small retail packs for soups are therefore made from heat sealable laminates containing alumunium foil barrier (Paine et *al.* 1992). Extruding polyethylene on aluminium foil and laminating the plain side of the foil to sulfite or Kraft paper may construct the air- tight envelopes. In package desiccation is not practical but inert gas packing is used. For catering packs, cartons, containing paper or laminated bags or large cans (metal) with resealable lids are common.

For small packs triple laminates consisting of polyethylene, aluminium foil and paper are used as well as flexible films with very low water vapor transmission rates.

Because of the low moisture content of dehydrated soups final heat processing is unnecessary. To protect product from oxidation the container is evacuated and the vacuum filled with an inert gas before sealing. The oxygen content of the gas in the filled container not less than two days after filling should not exceed 20%.

2.6. Shelf-life evaluation

Foods are perishable in nature and numerous changes are taken place in foods during processing and storage. The conditions used in processing and storing foods are adversely influenced the quality attributes in foods. After a certain period in the storage one or more quality attributes of a food may reach an undesirable state. Then the food is considered unsuitable for consumption and it is said to have reached the end of its shelf life.

Environmental factors such as temperature, humidity, oxygen and light can trigger several reaction mechanisms that may lead to food degradation. As a consequence of these mechanisms, food may be altered to such an extent that the consumer either rejects them, or they may become harmful to the person consuming them. It is therefore imperative that a good understanding of different reactions that cause food deterioration is gained prior to developing specific procedures for the shelf life evaluation of foods.

The influence of moisture content and water activity (a_w) are of profound importance in determining shelf life of foods, since they affect physical (hardening, drying out) and physio-chemical properties, chemical changes (e. g. non-enzymatic browning), microbiological spoilage, particularly with unprocessed foods (Man *et al.* 1994).

2.6.1.Chemical changes

During the processing and storage of foods, several chemical changes occur that involves the internal food components and the external environmental factors. These changes may cause food deterioration and reduce the shelf life. The most important chemical changes are associated with enzymatic reactions, oxidative reactions, particularly lipid oxidation that alters the flavour of many lipids containing foods, and non enzymatic browning that causes changes in appearance.

At favourable temperatures, such as room temperature, many enzymatic reactions proceed at rapid rates altering the quality attributes of foods. In the production of instant soups enzymes are destroyed that are in the soup puree during the drum drying process. So, there is no chance to enzymatic reactions in the dried product. During the preparation of raw materials such as vegetables may be subjected to enzymatic reactions. Blanching vegetables, and washing vegetables, apparatus with SMS solution can minimize this. In addition to temperature, other environmental factors such as oxygen, water and pH induce deterious changes in foods.

The presence of unsaturated fatty acids in foods is a prime reaction for the development of rancidity during storage as long as oxygen is available. While development of off-flavours is markedly noticeable in rancid foods, the generation of free radicals during the auto catalytic process leads to other undesirable reactions, for example, loss of vitamins, alteration of colours, and degradation of proteins.

2.6.2.Physical changes

Dried foods when kept in high humidity may pick up moisture and become soggy. The establishment of a moisture sorption isotherm of a package food is a necessary prerequisite for estimating its shelf life when moisture changes affect food quality. When the practical effects of specific moisture contents are known, this prerequisite becomes sufficient to determine shelf life, providing that the water vapor permeability of the packaging material is known. Physical changes in foods may occur quickly, chemical and microbial changes usually occur more slowly.

The principle factors affecting the life of packaged foods are;

1. The nature of the food and the mechanisms by which undergo deterioration, e.g. sensitivity towards moisture and oxygen, and the possibility of internal chemical and physical changes occurring.

2. The size of the package in relation to its volume.

3. The atmospheric conditions (principally temperature and humidity) which the package is required to withstand during transit and before use.

4. The overall resistance of the package to the passage of moisture, atmospheric gases and odors, including the resistance of seals, closures and folded areas.

CHAPTER 3
MATERIALS AND METHOD

3.1.Location

The experiments were carried out at the quality control laboratory of the Mr. Hop Lanka Foods (Pvt.) Ltd. Proximate analysis and microbial aspect of the product was conducted at the Food Science Laboratory of the Faculty of Applied Sciences of the Sabaragamuwa University of Sri Lanka.

3.2. Materials

3.2.1.Production of dehydrated soup

1. Carrots
2. Corn flour
3. Leek
4. Sugar
5. Salt
6. Monosodiumglutamate
7. Tomato.
8. Dhal
9. Garlic
10. Potatoes
11. Spices
12. Hydrogenated vegetable fat
13. Onion
14. Anti-oxidants
15. Sodium Metabisulphite
16. Sodium Carbonate
17. Aluminium foil laminated polyethylene
18. Stainless steel knives
19. Vessels

20. Steam jacketed kettle
21. Blender
22. Drum drier
23. Sealer

3.2.2.Proximate Analysis

3.2.2.1.Determination of moisture

3.2.2.1.1.Apparatus

1. Metal dish with a lid
2. Electrical oven at 105^{0}C
3. Desiccator
4. Electrical balance

3.2.2.2.Determination of total fat

3.2.2.2.1.Apparatus

1. Beaker
2. Hot water bath
3. Bottom flatted round flask
4. Electronic balance
5. Pipette with a pump
6. Flask

3.2.2.2.2.Reagents

1. 95% Ethanol
2. HCl solution
3. Ether
4. Pet ether

3.2.2.3.Determination of protein

3.2.2.3.1.Apparatus

1. Distilled water
2. Kjeldhal tube
3. Kjeldhal tablet

4.Kjeldhal apparatus

5.Distillation unit

6.Titration flask

7.Electronic balance

3.2.2.3.2.Reagents

1.Conc. Sulfiric acid

2. 0.04M HCl

3. 40% NaOH solution

4. $Na_2S_2O_3$ solution

5. 5% boric acid

6. Methylene blue and methl red indicators

7.Distilled water

3.2.2.4.Determination of crude fibre

3.2.2.4.1.Apparatus

1.Electrical oven at 105^{0}C

2.Reflux condenser

3.Buchner funnel

4.Muffle furnace at 600^{0}C

5.Crusiible

6.Electronic balance

3.2.2.4.2.Reagents

1.Concentrated Sulfuric acid (0.0128mol/l solution)

2.Ethanol 95%(v/v)

3.Conc.Sodium hydroxide

3.2.2.5.Determination of ash

3.2.2.5.1.Apparatus

1. Silica dish
2. Bunson flame in fume cupboard
3. Muffle furnace at 500^{0}C
4. Electronic balance

5. Desiccator

3.2.3.Coliform test

3.2.3.1.Apparatus

1.Test tubes

2.Durham tubes

3.Pipettes

4.Autoclave

5.Incubator

6.Cotton plugs

7.Aluminium foil

3.2.3.2.Reagents

1.Single strength and double strength lactose broth

2.Distilled water

3.Prepared soup

3.2.4.Determination of free fatty acid

3.2.4.1.Apparatus

1.Hot water bath

2.Thermometer

3.Burette with a stand

4.Titration flask

5.White tile

6.Stopper

3.2.4.2.Reagents

1.0.05M NaOH

2.Phenolphthalene

3.2.5.Sensory evaluation

1. Instant soup types available in market
2. Yoghurt cups
3. Spoons

4. Electrical kettle
5. Oven
6. Water glasses
7. Questionnaire papers
8. Pens

3.2.6. Determination of water activity

3.2.6.1.Apparatus

1.Boiling tubes
2.Test tubes
3.Electronic balance
4.Electrical oven
5.Desiccator
6.Para films

3.2.6.2.Reagents

1. LiCl
2. $MgCl_2$
3. K_2CO_3
4. $CoCl_2$

3.3.Methodology

3.3.1.Formulation Development

Number of vegetable soup formulas, which have been developed by food scientists, were used to optimize the ingredients used in homemade vegetable soup. Some other ingredients used in existing formulas were replaced with locally available ingredients to develop an instant vegetable soup formula. Four judges were participated to decide acceptability of freshly prepared soups, which were prepared by changing quantity of some ingredients.

3.3.2.Preparation and Reconstitution of Dehydrated Soup

3.3.2.1.Preparation

Fresh vegetables in good quality were used to prepare the soup. They were weighed on live weight, trimmed and washed with SMS solution prior to process. Other ingredients, which were in good quality, were used for the production. They also weighed according to the developed formula. Stainless steel knives and other apparatus were also washed with Sodium Metabisulphite solution in order to minimize enzymatic browning.

Some vegetables such as potato and carrot were subjected to hot water treatment to facilitate peeling. Dhal and other vegetables like leek, cabbage and onion were pre cooked in a stainless steel steam jacketed kettle.

Then all ingredients were blending together to obtain a soup puree by using an electrical blender.

The soup puree was dried on a drum drier, which has 120^{0}C to 170^{0}C temperature usually.

The bulk soup powder was packed in metalized polyethene packets and stored in ambient temperature.

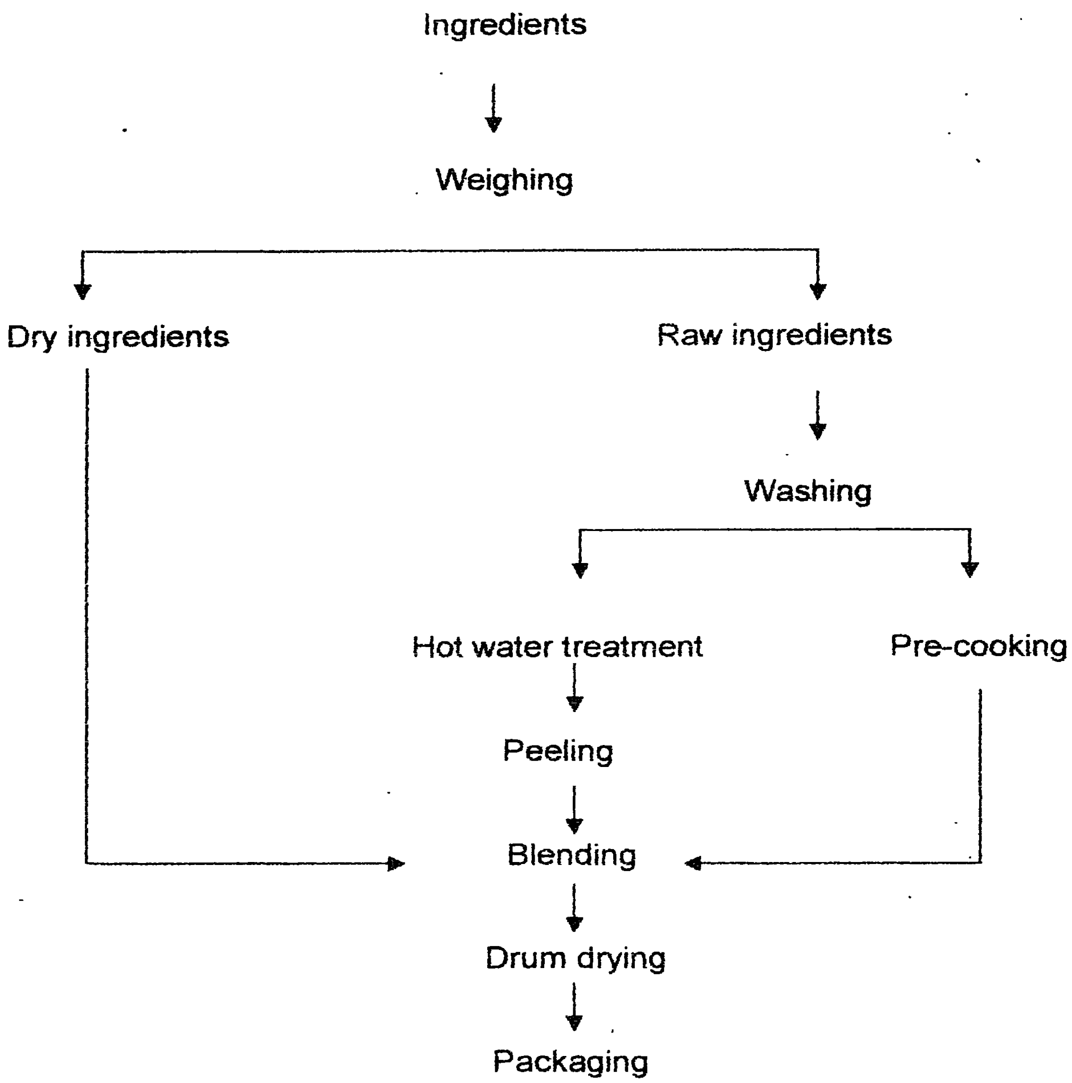
3.3.2.2.Reconstitution

The required amount of soup powder to prepare a cup of soup was determined by adding hot water as follows.

Table:3.1.Reconstitution of soup

Hot water(ml)	10	20	30	40	50	60	70	80
Soup powder(g)	5	5	5	5	5	5	5	5

Figure 3.1.Flow chart of production process



3.3.3.Proximate analysis

3.3.3.1.Determination of moisture

The metal dish, dried in an oven and cooled in a desiccator was weighed by using an electrical balance. Ten grams of the sample was placed on weighed dish (w1) and weighed using the balance (w2). This was put in an oven maintained at 105^{0}C for 2 hours, cooled in a desiccator to room temperature and weighed. Drying. Cooling, weighing were repeated until a constant weight (w3) obtained.

Calculation

$$\text{Percentage of moisture (dry basis)} = \frac{(W2 - W3) \times 100}{W3 - W1}$$

3.3.3.2.Determination of fat

3.00g of soup powder (w) were placed in 50 ml beaker. Then 2 ml of 95% ethanol and 10 ml of HCl (prepared by adding 25 ml of conc. HCl and 1ml of water) were added and mixed thoroughly. The mixture was placed in a hot water bath at 70^0 to 80^0C and stirred for 30 minutes frequently. The beaker was removed from the water bath and allowed to cool in the atmosphere. 10ml of ethanol was added into mixture and then transferred into a bottom flatted round flask. The beaker was washed with three portions of 25 ml of ether and added into the flask. The flask was stopped with a cork and shaked vigorously for few minutes and also with 25 ml of pet ether. The flask was standard until a clear layer of pet ether appeared. The upper layer was taken into a clean dry previously weighed flask by using a pump. The content was dried in a water bath at 90^0C until a constant weight (w2) was obtained.

Calculation

$$\text{Percentage of total fat} = \frac{(w2 - w1) \times 100}{w}$$

3.3.3.3.Determination of protein

Weighed de-fatted sample (w) was placed in a cleaned, dried Kjeldhal tube. Kjeldhal tablet, which contained Se added into concentrated Sulfuric acid in the tube. The tube was heated for 4 hours for digestion process and then allowed to cool for 1 hour. Distilled water 15 ml were added to the tube. Then distillation was done after adding 75ml of NaOH and $Na_2S_2O_3$ solutions. Produced NH_3 was trapped into 5% boric acid solution and titrated with concentration (C) 0.1 M HCl solution. At the end point when colour changed from pink to greenish the used HCl volume (V) was recorded.

Calculation

$$\text{Percentage of Nitrogen (N)} = \frac{V \times C \times 100}{W}$$

$$\text{Percentage of protein} = N \times 6.25$$

3.3.3.4.Determination of crude fibre

W1 amount of defatted, dried sample was transferred into boiled 200ml of 0.128 mol l^{-1} sulfuric acid and continued boiling for one minute. The sample was poured into the funnel and washed with boiling water until the washings were no longer acidic to Litmas papers. The sample was added into the flask that containing boiled 200ml of 0.128 mol l^{-1} Sodium hydroxide and boiling was continued for one minute. The boiled sample was washed with distilled water until alkalinity was removed. The residue was transferred into boiling water and transferred into the crucible. Then the residue was washed with 15 ml ethyl alcohol. Ovens drying, cooling in a desiccator and weighing were repeated until a constant weight (w3) was obtained. The crucible was transferred in the furnace and the content of crucible was incinerated. Then the sample was cooled in a desiccator and final weight (w2) was obtained by using an electrical balance.

Calculation

$$\text{Percentage of crude fibre} = \frac{(w3 - w2) \times 100}{w1}$$

3.3.3.5.Determination of ash content

5.00 g of the sample (w1) was placed in a weight known (w2) clean dry silica dish. It was ignited slowly over a Bunson flame until no more fumes evolved. The dish was transferred to the Muffle furnace set at 500^{0}C . The content was incinerated for 3 hours until sample was free from black carbon particles. The process of igniting, cooling in a desiccator and weighing was repeated until a constant weight (w3) obtained.

Calculation

$$\text{Ash content (\%)} = \frac{(W3 - W2) \times 100}{W1}$$

3.3.4.Determination of free fatty acids

18 g of the soup powder in 200ml of distilled water in a conical flask were placed in a hot water bath at 40^0C for one hour with the flask loosely stopped. Then this was filtered. 100 ml of clean filtrate was titrated with 0.05 M NaOH solution after adding three drops of phenolphthalein. The titrated amount was noted at the end point where colour changed from colour less to pink colour.

Calculation :

Free fatty acid amount = Titrated 0.05 M NaOH amount x 0.0068 (Pearson. D, 1976) .

3.3.5.Coliform test

1. Preparation of single and double strength lactose broth.

2. 10 ml strength lactose broth (SSLB) were distributed in each to ten test tubes and 10ml double strength lactose broth (DSLB) to 5 test tubes.

Table 3.2.Composition of lactose broth

Ingredient	single strength	Double strength
Beef extract	3 g	3 g
Peptone	5 g	5 g
Lactose	5 g	5 g
Distilled water	1000 ml	500 ml

3. The Durham tubes were introduced in all tubes and were sterilized after filling the tubes without air bubbles. All sets of tubes were sterilized in an autoclave at 121°C, 15 Psig for 20 min. the test tubes were cover with cotton plugs and Al foil before autoclaving.

4. DSLB tubes were labeled as 1 ml, the next 5 SSLB tubes were labeled as 0.1ml, and the other 5 SSLB tubes were as 0.01 ml.

5. 1ml of the prepared a cup of soup sample was inoculated for each DSLB tubes.

6. The tubes were incubated at 37°C were examined the gas formation in the Durham tubes at 24 hours and 48 hours.

3.3.6.Sensory Evaluation of Formulas

An untrained consumer type panel consisting of 15 students of the Sabaragamuwa University was participated in the exercises. It was intended to compare the consumer preference of the instant soup with commercially available soup cubes. Samples were evaluated at the end of storage of 3 months. The two samples used for comparison were coded with three digit random numbers;

Comparison with Magee Soup Cubes
312-Dehydrated soup powder
534-Inastant soup cubes

Comparison with Knorr Soup Cubes
312-Dehydrated soup powder
534-Instant soup cubes

Panelists were assigned two samples for evaluation. They were provided with a questionnaire, which is given at Appendix I.

3.3.7. Determination of water activity

A randomly selected sample was used for the test. Samples weighed into weight known test tubes and were kept with water activity known salts for 2 weeks until to reach equilibrium. Then weight of each sample and their dry weights were obtained. The apparatus were arranged as follows.

Figure:3.2.Diagram of apparatus used in determination of water activity

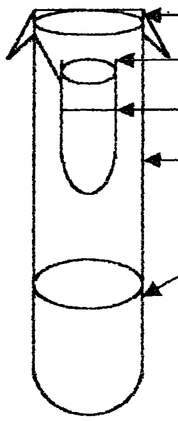


Table:3.3.Samples at different temperatures and water activities

Temperature (^{0}C)	Water activity of salts in solid form					
	A	B	C	D	E	F
	0.1	0.2	0.32	0.43	0.5	0.65
8	A1	B1	C1	D1	E1	F1
28	A2	B2	C2	D2	E2	F2
45	A3	B3	C3	D3	E3	F3

A-LiCl

C-$MgCl_2$

D-KCO_3

F-$CoCl_2$

Weight of the samples was obtained after two weeks. Then dry weight of samples were obtained by drying them in an oven at 110^{0}C for 2 hours, cooling in a desiccator and weighing using an electrical balance.

Calculation

W1-initial weight of samples
W2-weight after 2 weeks
W3-dry weight

$$w = \frac{(w2-w3) \times 100}{w3}$$

A graph was drawn to determine shelf life of the product at ambient temperature by taking water activity as x axis and w as y axis.

CHAPTER 4
RESULTS AND DISCUSSION

4.1.Formulation Development

The instant vegetable soup was produced using vegetables as the major ingredient of the developed formula. It is not contain artificial colourings, flavours and higher salt taste. Sour and pungency tastes of the soup should be improved by developing the formula.

Through out the product's storage life free fatty acid oxidation should be prevented, for this vitamin E tablets were used as an anti-oxidant. Anti-oxidants also prevent colour changes due to non-enzymatic browning.

Monosodium glutamate was used to accentuate other flavours, but there is considerable different options as to whether this amino acid salt has own flavour that mask flavours of others. Spices and salt in the formula act as preservatives in the product.

4.2.Preparation and Reconstitution of Dehydrated Soup

4.2.1.Preparation

Sodium metabisufite solution was used to washing, minimize enzymatic browning of vegetables before the hot water treatment or pre-cooking steps. Hot water treatment was used to facilitate peeling of carrots and potatoes.

Moisture content of the product after dehydration should be about 2%. Therefore it is important to remove all moisture by maintaining rounds per minute of drum drier and its temperature.

At the initial stage there was a light yellowish colour and a good aroma, but it has become lower due to inability of package to protect the product from light and oxygen. The package, metalized polythene caused to the changes of colour and aroma but still in acceptable range. If aluminium foil laminated packs could be used as the package it would be minimized those slight changes. Specially dehydrated soups require protection from oxygen and moisture as well as from loss of volatile flavourings.

4.2.2.Reconstitution

The best reconstitution was obtained by 5 g of soup powder with 50 ml of hot water, but hot water up to 70 ml could be used to reconstitute in consumer acceptable range. The prepared soup was thickened and flavourful. The consumer can obtain same content of vegetables and other ingredients consuming this soup same as a freshly prepared vegetable soup.

Reconstitution can be done even without hot water, but consumer acceptability is lower than a soup that prepared with hot water. The prepared soup was colloidal solution with sediment. Homogenization is one of the methods that can be used to solve this problem but it is not applicable for dehydrated soups like products due to large particle size and has to subject higher temperature at final stage.

Plate:4.1.Reconstituted dehydrated soup

4.3. Proximate Analysis

There are no standards available to compare with the results of the chemical analysis of nutrient composition of the product. The values may vary within a range due to personnel error and instrumental errors, which may have occurred.

4.3.1. Determination of Moisture

Weight of the petri dish (w1)	= 143.2025 g
Weight of the sample with the dish (w2)	= 153.2061 g
Constant weight with the dish (w3)	= 152.9217 g

The mean value for moisture content is 2.8%.

4.3.2. Determination of Fat

Weight of sample	= 3.001 g
Weight of dry flask	= 132.854 g
Constant weight of fat with flask	= 133.266 g

The total fat percent is 13.89

4.3.3. Determination of Protein

Weight of the de-fatted sample (w)	= 12.143
Volume of 0.1 M HCl titrated (v)	= 1.5 ml
Concentration of HCl (c)	= 0.1mol/ 1 l
Percentage of Nitrogen	= 1.2192

The protein percentage is 7.62

4.3.4.Determination of Crude Fibre

Weight of the de-fatted sample (w1) = 5 .4072 g
Weight of fibre + organic matters + gooch crusible(w3) = 17.4726 g
Final constant weight of fibre with gooch crusible (w2) = 17.2781 g
The crude fibre percentage is 3.6.

4.3.5.Determination of Total Ash

Weight of the sample (w1) = 5.008 g
Weight of silica dish (w2) = 17.913 g
Constant weight of dish with ash (w3) = 18.864 g
The total ash percentage is 19.03

4.4.Sensory Evaluation

Table:4.1. Comparison test with Magee Soup Cubes

	Rank total for characters							
Judges	Colour		Taste		Aroma		Mouth feel	
16	A	B	A	B	A	B	A	B
	21	27	26	22	27	21	22	26

A - 312 - Dehydrated soup powder
B – 534 - Instant soup cubes

Table :4.2.Comparison test with Knorr Soup Cubes

Judges	Rank totals of characters							
	Colour		Taste		Aroma		Mouth feel	
	A	B	A	B	A	B	A	B
16	26	20	25	23	25	23	24	24

A – 312- Dehydrated soup powder

B – 534– Knorr Soup Cubes

The rank totals of above two comparison tests were compared with the relevant values in the table (see Appendix II). In these tests two different samples numbered as 312 and 534 were subjected to16 judges. The relevant values in the table are, the upper values 20-28 and the lower values 21-27,.

Rank sums of each character of sample No. 312, was higher than upper left value. In sample No.534 values were lesser than upper right value in the block. Therefore, statistical significance of consumer acceptability of each character at the 5% level of significance was not indicated between samples.

When considering the lower tabular entries 21-27, the rank sums of each character of sample No,312 were equal or higher than the lower left value and for Sample No. 534 was equal or lesser than lower right value. Therefore no significance different between samples at 5% level of significance.

The Comparison tests were done with two types of instant vegetable soup cubes commercially available in Sri Lankan market. The both tests showed that there are no significant difference of consumer acceptability for colour,. flavour, aroma and mouth feel of dehydrated soup powder at 5% level of significance.

4.5.Determination of Free Fatty Acids

The average of titrated amount of 0.05M NaOH was 13.3 ml and the free fatty acid content was 0.0904g.

After four months of storage life, free fatty acid content of soup powder was lesser than the required level that is lesser than 0.1g. Therefore it contained the required level of free fatty acid and no rancidity occurred.

4.6.Coliform Test

Presumptive test, the first step of coliform test was negative because there was no gas formation inside Derham tubes. Therefore further testing is unnecessary.

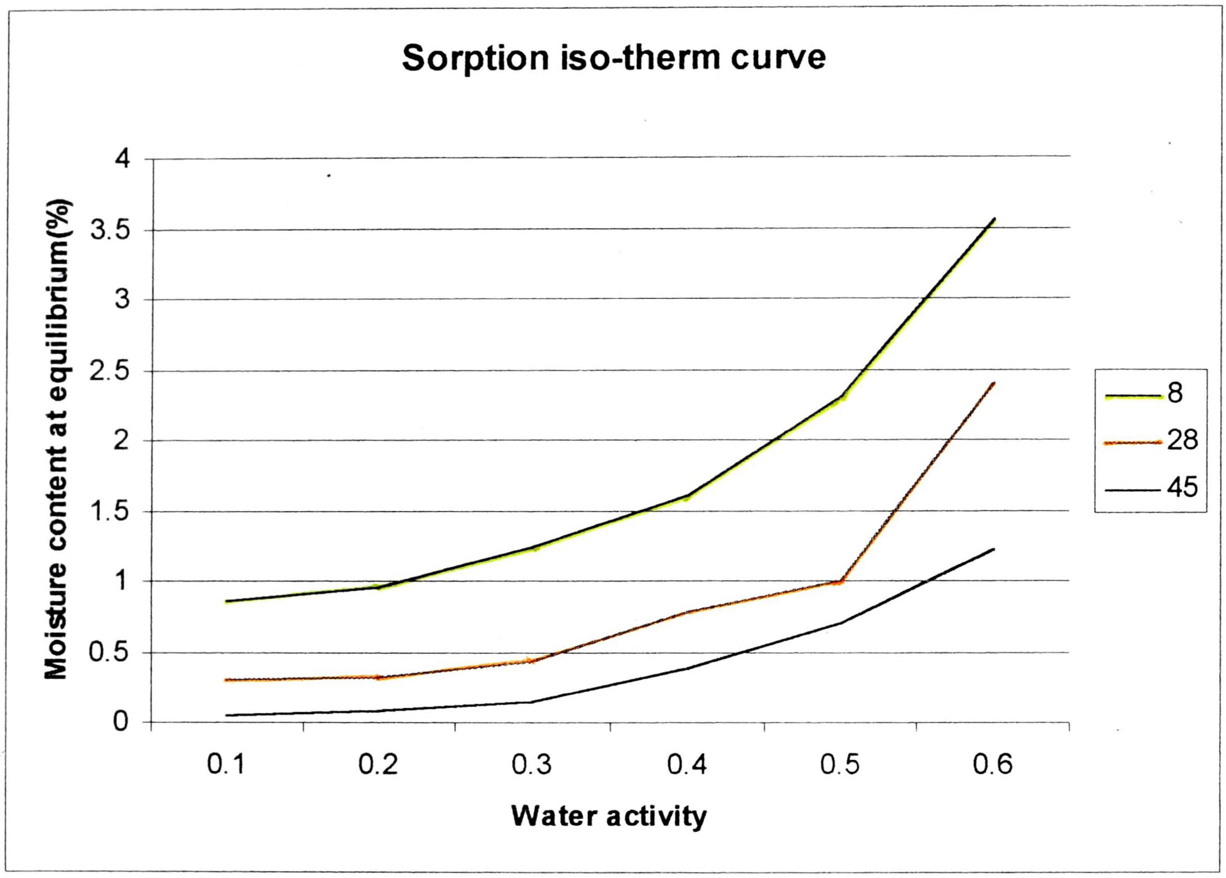
During the drying process, the product was sterilized hence, the soup puree subjected to approximately 135°C temperature. It can be assured that there was no post fecal contamination in the product.

4.7.Determination of Water Activity

Table : 4.3.Readings of determination of water activity

Sample	Weight of sample	Wt. After 2 weeks(m1)	Dry weight(m2)	[(m1-xm2)x100]/m2
A1	3.148	3.122	3.0876	0.0344
A2	3.8021	3.7295	3.7184	0.2910
A3	3.075	2.7973	1.8068	0.05
B1	-	-	-	-
B2	-	-	-	-
B3	-	-	-	-
C1	3.403	3.3982	3.3546	1.248
C2	3.2956	3.4986	3.3864	0.448
C3	3.2651	3.408	3.437	0.07
D1	3.442	3.4485	3.405	1.675
D2	2.5035	2.5035	2.4843	0.76
D3	3.028	3.1759	3.1716	0.136
E1	-	-	-	-
E2	-	-	-	-
E3	-	-	-	-
F1	3.153	3.193	3.0835	3.551
F2	3.3286	3.358	3.3286	1.95
F3	3.201	2.8913	2.8804	0.38

Figure: 4.1.Sorption isotherm curve



Sorption isotherms studies should be carried out further more because readings were less accurate. The product contains very low moisture content so product absorbed atmospheric moisture during weighing. Certain chemicals, which have a particular water activity, were not available therefore a complete sorption isotherm curve could not be drawn.

Data obtained from this study were not sufficient to get exact determination of the water activity of product at room temperature and at 45^{0}C at 2.8% moisture content on dry basis.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1.Conclusion

The production of an instant natural vegetable soup is to fulfill market requirement for such type of product. The product can be considered as a new product, which contained more vegetables, and less salt. According to the results of sensory evaluation, this product got similar consumer acceptability as of instant soup cubes, which are already available in the Sri Lankan market. The soup powder contains 2.8% of moisture, 13.9% of fat, 7.62% of protein, 3.6% of crude fibre and 19% of total ash. This product can be considered as a non-meat food product for vegetarians, specially for children and patients. Shelf life of this product is up to date is four months and still in an acceptable level.

5.2.Recommendations For Further Studies

1. Salt taste, sour taste and astringency can be improved by developing the formula.
2. Costing for the production should be done.
3. A market research should be carried out for consumer acceptability of the product.
4. Shelf-life studies should be carried out further more.

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APPENDIX I

Comparison

Test For Sensory Evaluation

Name ....

Date ....

Instructions

1 Please taste the samples according to following order.

312 534

2. Rank the best sample as '1', the other sample as '2'.

	Colour	Taste	Aroma	Mouth Feel
312				
534				

Comment s -

Thank you.

Source:Laboratory methods for Sensory Evaluation of food,Larmond,E.(1977),P 38

APENDIX II

No.of reps.	No. of treatments or sample ranked								
	2	3	4	5	6	7	8	9	10
2	....	....	....	....	....	....	....	....	....
	....	....	......	3-9	3-11	3-13	4-14	4-16	4-18
3	....	......	....	4-14	4-17	4-20	4-23	5.25	5-28
	....	4-8	4-11	5-13	6-15	6-18	7-20	8-22	8-25
4	....	5-11	5-15	6-18	6-22	7-25	7-29	8-32	8-36
	....	5-11	6-14	7-17	8-20	9-23	10-26	11-29	13-31
5	....	6-14	7-18	8-22	9-26	9-31	10-35	11-39	12-43
	6-9	7-13	8-17	10-20	11-24	13-27	14-31	15-35	17-38
6	7-11	8-16	9-21	10-26	11-31	12-36	13-41	14-46	15.51
	7-11	9-15	11-19	12-24	14-28	16-32	18-36	20-40	21-45
7	8-13	10-18	11-24	12-30	14-35	15-41	17-46	18-52	19-58
	8-13	10-18	13-22	15-27	17-32	19-37	22-41	24-46	26-51
8	9-15	11-21	13-27	15-33	17-39	18-46	20-52	22-58	24-64
	10-14	12-20	15-25	17-31	20-36	23-41	25-47	28-52	31-57
9	11-16	13-23	15-30	17-37	19-44	22-50	24-57	26-64	28-71
	11-16	14-22	17-28	20-34	23-40	26-46	29-52	32-58	35-64
10	12-18	15-25	17-33	20-40	22-48	25-55	27-63	30-70	32-78
	12-18	16-24	19-31	23-37	26-44	30-50	33-57	37-63	40-70
11	13-20	16-28	19-36	22-44	25-52	28-60	31-68	34-76	36-85
	14-19	18-26	21-34	25-41	29-48	33-55	37-62	41-69	45-76
12	15-21	18-30	21-39	25-47	28-56	31-65	34-74	38-82	41-91
	15-21	19-29	24-36	28-44	32-52	37-59	41-67	45-75	50-82
13	16-23	20-32	24-41	27-51	31-60	35-69	38-79	42-88	45-98
	17-22	21-31	26-39	31-47	35-56	40-64	45-72	50-80	54-89
14	17-25	22-34	26-44	30-54	34-64	38-74	42-84	46-94	50-104
	18-24	23-33	28-42	33-51	38-60	44-68	49-77	54-86	59-95
15	19-26	23-37	28-47	32-58	37-68	41-79	46-89	50-100	54-111
	19-26	25-35	30-45	36-54	42-63	47-73	53-82	59-91	64-101
16	20-28	25-39	30-50	35-61	40-72	45-83	49-95	54-106	59-117
	21-27	27-37	33-47	39-57	45-67	51-77	57-87	63-97	69-107
17	22-29	27-41	32-53	38-64	43-76	48-88	53-100	58-112	63-124
	22-29	28-40	35-50	41-61	48-71	54-82	61-92	67-103	74-113
18	23-31	29-43	34-56	40-68	46-80	51-93	57-105	62-118	68-130
	24-30	30-42	37-53	44-64	51-75	58-86	65-97	72-108	79-119
19	24-33	30-46	37-58	43-71	49-84	55-97	61-110	67-123	73-136
	25-32	32-44	39-56	47-67	54-79	62-90	69-102	76-114	84-125

Source:Statistical Chart 5,Laboratory Methods for Sensory Evaluation of Food

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