DEVELOPMENT OF INSTANT SPICED CURRY POWDER FORMULA

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To all my well wishers and loved ones.

ABSTRACT

In the modern world the people are busy with their routine work. They have less time to spend for preparing there meals. In an Asian country like Sri Lanka ancient people prepared the meals with rice and curries. To make these curries they used different spices with different proportions in different curries. Preparing these separate blends of curry mixes is a time consuming operation. For the modern people there should be a way of preparing curries by just adding a spoon of spicy powder blend. It should be compatible to make many types of curries.

The objectives of this project were, to formulate a universal spicy curry powder, and to find the suitable packing material and the best grinding method to retain the volatile oil optimally.

The formulation was done in five steps of sensory evaluation with different proportions of spices that would have high flavour index values and considerably responsible for sensory parameters. By conducting sensory evaluation at the end of each formulation the best sample was chosen out of three samples. As taking the best sample from the previous sensory evaluation as the base next formulation step was done. The final formula was obtained by this method. The effect of mills and the best packing material was determined by the steam distillation method.

Finely a better formula of curry powder mix that would suitable for many curries was formulated. Including coriander 52%, cumin 10.8%, fennel 20%,cinnamon 03%, clove 03%, ginger 0.9%, fenugreek 6%, turmeric 5%, cardamom 0.3%, chillies 8%, and curry leaves 1.7%. As the best grinding mill hammer mill was selected. As the best packing material Nylon packs were selected. Further studies should be carried out on evaluating the shelf life of this product.

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CHAPTER 01

INTRODUCTION

1.1 General Introduction

What is a curry? The word curry is an English corruption of the shortened Indian word "turri" for the Hindustani word "turcurry". In the Tamil district, curry means cookery but the term has become generic for sauces which wary composition from province to province. To an Indian or a Sri Lankan family, curry is not a blend of herbs and spices to be taken out from a jar or other vessel for use on any type of food but a special blend of selected spices skilfully put together for a single dish. Each dish deserves its own particular creative blend of spices. Usually several different curries are prepared for use at the same meal. As early as the third century, the Greeks described curries as Indian food. The better Indian curries are skilfully blended mixtures of from nine to twenty-five herbs and spices, to bring out each of the individual rich bouquets and flavours. Milder flavoured curries are prepared in Northern provinces of India while the southern provinces favour hotter, more pungent curries. In ancient time authentic Sri Lankans prepared their curries by using a blend called "thuna Paha", the theory behind this is they ground Coriander, Cumin, Fennel, Turmeric and Chillies in the traditional stone grinder. And made five balls out of these five ingredients by adding some water. They kept these balls in a coconut shell and on top of each ball; they placed a crystal of salt. By the time, the salt crystal will absorb moisture and will dissolve and flow around the balls they will be protected by microbes to some extend until it is used in the curry preparation. The flavour of the curry was depended on the cook's experience. As the spices contain some natural antioxidants and other medicinally valued compounds Asians had the opportunity of healthy life than westerners.

Now world has being changed to a fast moving wave. So the traditional housewife or mother is not a common site a past. They also are going to jobs, looking after kids, do other work in a hurry. To this busy woman preparing the traditional five balls of flavour is impossible. Therefore, there should be a way of preparing curries by using a specially blended multi purpose curry powder mix that would enough to prepare a curry by just a spoon of it. To this the formulation should be done by the consumer preference and should concern on he flavour profile and also on flavour indices.

Spices contain volatile oils. These are the substances that responsible for the flavour of spices. Volatile oil start to evaporate at $30^{O}C$ and because of this the spices have to kept in suitable packs in order to retain the aroma and flavour for longer. Processing methods are also important for the quality of the ground spice powders. When grinding the heat can be generate in the mill and can affect the final volatile oil content. Therefore, controlling of the process, storage and packing are important facts in this curry powder preparation.

1.2. Objectives

- To formulate a instant curry powder blend that will suit for many dishes.
- To find out the best packing material for the spice powders.
- To find out the best grinding, storage conditions for spice blends.

CHAPTER 02

REVIEW OF LITRATURE

2.1 Ingredients

2.1.1 Coriander

Botanical name: - *Coriandrum sativam L.*

Family: - Umbelliferae.

Coriander is a glabrous, aromatic, annual herb and it is 30- 90 cm in height. Coriander fruits are commonly used as a spice.

1-Whole plant, 2- young plant, 3- flower, 4- fruit, 5- mericarp (seed)

Figure -1 Coriander (Grieve, 1995)

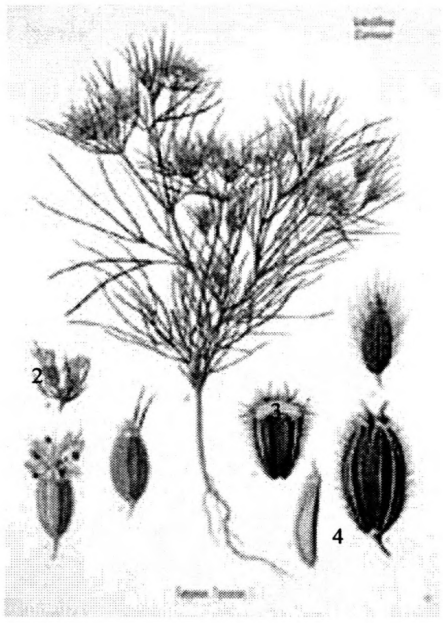
Coriander is well famous for its medicinal value. The leaves are acrid, astringent, aromatic, analgestic, anti inflammatory and styptic and are useful in chronic conjunctivitis, haemorrhoids, jaundics, and odontalgia. The fruits are aromatic, bitter, and are useful in vitiated conditions of pitta, burning sensations, cough, bronchitis, vomiting, flatulence, diarrhoea, dysentery, chronic conjunctivitis, helminthlasis, haemorrhoids, intermittent fevers, hyperdipsia, and giddiness. (Nrayan *et al.*, 2003)

Proximate analysis of coriander has shown that 100 g of air- dried coriander contains approximately, water 11.0 g, crude protein 11.0 g, fatty oil 19.0 g, carbohydrates 22.9 g, crude fibre 28.0 g, mineral constituents 5.0 g and essential oils 1.0 g. The essential oil content varies between almost zero and 2%. The main component is linalool, some of other compounds are pipene, γ terpinene, geranyl acetate, champor, geraniol, linalyl acetate, thymol, β phellandrene, citranelol, 1-8-cineole (Narayan *et al.*, 2003)

2.1.2 Cumin

Botanical name:- *Cuminum cyminum (LINN.)*

Family:- Umbelliferae



Whole plant, 2- flower, 3- fruit, 4-seed

Figure-2, cumin (Grieve, 1995)

It Cumin contains 7.0 g of water, 18.0 g of protein, 4.0 g of fat, 29.0 g of carbohydrate, 17.0 g of fibre, 6.0 g of ash (Ca-605 mg, P-570 mg, Fe-175 mg), 8 mg of niacin, 3 mg of ascorbic acid, 17.0 g foreign matter, Dried cumin contains about 2.5-5% of essential oil (Guzman *et al.*, 1999). The strong aromatic smell and warm, bitterish taste of cumin fruits are due to the presence of a volatile oil (Grieve, 1995).

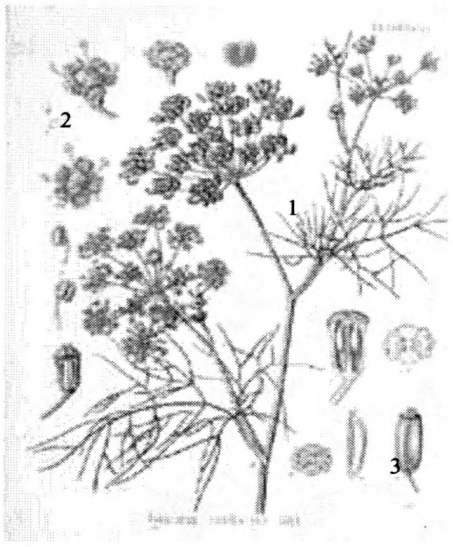
It is mainly used for culinary uses as in curry powders, beverages, liquors and cordials. The medicinal value of cumin showed that it is a stimulant, antispasmodic, and carminative. Formerly cumin had considerable repute as a corrective for the flatulency of languid digestion and as a remedy for colic and dyspetic headache. Bruised and applied externally in the form of a plaster, it was recommended as a cure for stitches and pains in the side caused by the sluggish congestion of indolent parts, and it has been compounded with other drugs to form a stimulating liniment.

2.1.3 Fennel

Botanical :- *Foeniculum vulgare*

Family:- Umbelliferae

Fennel is an aromatic, perennial herb 1-2 m high. The parts that uses are seeds, leaves and roots. The fruit are sweet tastes and pungent and smells is similar to anis seed.



1-whole plant, 2- flower, 3- fruit, 4-seed

Figure- 3 fennel (Grieve 1999)

The best varieties of fennel yield from 4 to 5 per cent of volatile oil. The principal constituents of which are Anethol and Fenchone (Grieve, 1995). It contains limonene, methyl chavicol, α-pinene, α-phellandrene, myresin, and cisocimene (Prajapathi *et al.*, 2003).

Fennel fruit is chiefly used medicinally with purgatives to allay their tendency to griping and for these purpose forms one of the ingredients of the well-known compound liquorices powder. Fennel tea, formerly also employed as a carminative, is made by pouring half a pint of boiling water on a teaspoonful of bruised Fennel seeds. Syrup prepared from Fennel juice was formerly given for chronic coughs. (Grieve, 1995)

Fennel is used to confer aroma to curry mixes, soups, meat dishes, souses, bakery and confectionary items, liqueurs and pickles. Fennel oil is used to flavour seasonings, confectionary, culinary preparations, tobacco, cordials and liqueurs.

2.1.4 Fenugreek

Botanical name:- *Foenum-graecum*

Family:- Leguminosae

Fenugreek is an erect annual herb, growing about 2 feet high, similar in habit to Lucerne. The seeds of Fenugreek have been used medicinally. The seeds are brownish, about 1/8 inch long, oblong, rhomboidal[1], with a deep furrow dividing them into two unequal lobes. Seeds are bitter taste and peculiar.

1-whole plant, 2- flower, 3- fenugreek bean, 4- seed

Figure-4 fenugreek (grieve 1995)

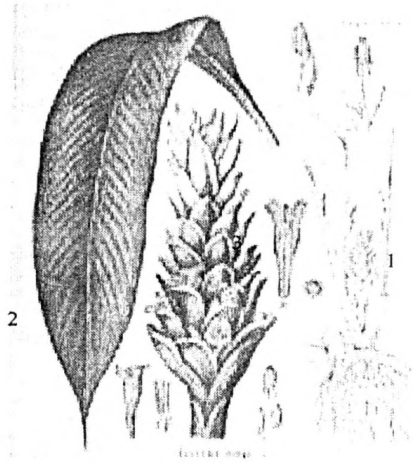
It contains about 28% mucilage, 5% of a stronger-smelling, bitter fixed oil, 22% proteins, a volatile oil, two alkaloids, Trigonelline and Choline, and a yellow colouring substance. The chemical composition resembles that of cod-liver oil, as it is rich in phosphates, lecithin and nucleoalbumin, containing also considerable quantities of iron in an organic form, which can be readily absorbed. Rebutter has noted the presence of trimethylamine, neurin and betain; like alkaloids, these substances stimulate the appetite by their action on the nervous system, or produce a diuretic or ureo-poietic effect. (Grieve, 1995)

2.1.5 Turmeric

Botanical name:- *Curcuma longa*

Family: - Zingiberaceae

A perennial plant with roots or tubers oblong, palmate, and deep orange inside. It has a peculiar fragrant odour and a bitterish, slightly acrid taste, like ginger, exciting warmth in the mouth and colouring the saliva yellow. It yields its properties to water or alcohol (Greive, 1995).



1-whole plant, 2-leave, 3- flower

Figure- 5 turmeric (Grieve, 1995).

The rhizome contains the pigment called "curcumin", and essential oil consisting of sesquiterpenes, zingiberene, D-a-phellandrene, tumerone, dehydotumerone, y and a-alanto lactone, curcumene, cineol. (Prajapathi *et. al,* 2003).

Turmeric is a mild aromatic stimulant seldom used in medicine except as a colouring. It was once a cure for jaundice. Its chief use is in the manufacture of curry powders. It is also used as an adulterant of mustard and a substitute for it and forms one of the ingredients of many cattle condiments. Tincture of Turmeric is used as a colouring agent, but the odour is fugitive. It dyes a rich yellow. Turmeric paper is prepared by soaking unglazed white paper in the tincture and then drying. Used as a test for alkaloids and boric acid. (Grieve ,1995)

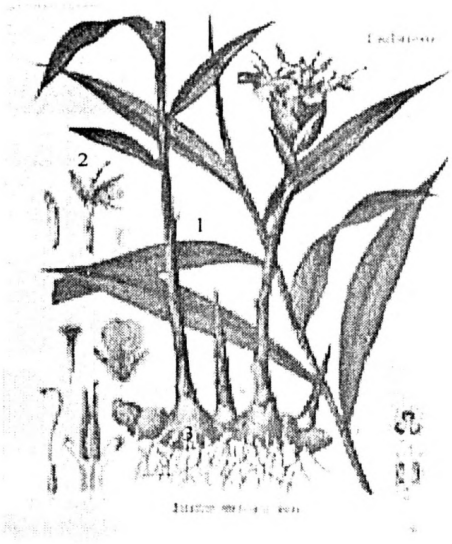
Other than that the rhizome is well known for its anti- gastric-ulcer, anti-inflammatory and cholagogic properties. It is prescribed in the trophy of gastric and duodenal ulcer, hepatitis, and jaundice, menstrual disorders, post –partum, or menstrual haematometra, contusions, rheumatism, pain in the extremities, boils and impetigo. It is also used as a poultice for wounds to avoid their cicatrisation.

2.1.6 Ginger

Botanical: *Zingiber officinale*

Family: Zingiberaceae

Ginger is a slender, perennial rhizomatous herb. The rhizomes are white to yellowish brown in colour, irregularly branched, somewhat annulated and laterally flattened. The growing tips are cowered over by a few scales. The surface of the rhizome is smooth and if broken a few fibrous elements of the vascular bundles project out from the cut ends. (Prajapathi *et. al*, 2003).



1-Whole plant, 2- flower, 3- rhizome
Figure -6 ginger (Grieve ,1995).

It contains α- Curcumene, β-D- curcumene; α-bergamortene, β- and champhene, γ-bisabolene, β-bourbornene, D- borneol and it's acetate, calamine, D- camphene, car-3-ene, -cedrol, citral, citronellol.

The raw ginger is acrid, thermogenic, carminative laxative and digestive. It is useful in anorexia, vitiated conditions of vita and kapha, dyspepsia, pharingopathy and inflammations. The dry ginger is acrid thermogenic. Emollient, appetizer, laxative, stomachic, stimulant, rubefacient, anodyne, aphrodisiac, expectorant, anthelmintic and carminative. It is useful in dropsy, otalgia, cephalalgia, asthma, cough, colic, diarrhoea, flatulence, anorexia, vitiated conditions of vita and khapa, dyspepsia, cardiopathy, pharyngopathy, cholera, nausea, vomiting, elephantiasis, and inflammations. It is also much used in several domestic preparations.

(Prajapathi *et. al*, 2003).

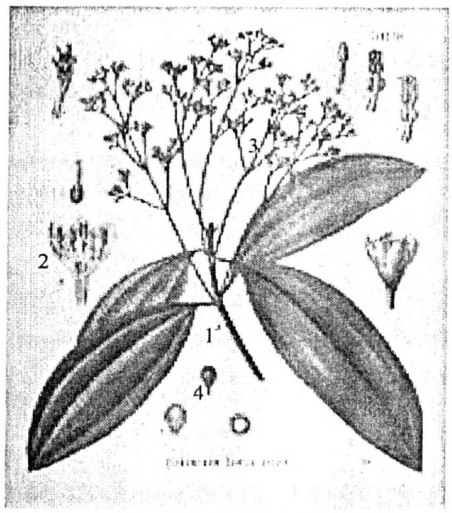
2.1.7 Cinnamon

Botanical name: - *Cinnamomum zeylanicum*

Family: - Lauraceae

A moderate sized evergreen tree, 8-18m in height and 50cm in diameter with reddish brown soft bark, having numerous small warts. . (Prajapathi *et. al*, 2003).

The part used is thick, coarse and dark barks and it contains pungent flavour, less sweet and delicate and slightly bitter. The bark is cut from the young shoots when the leaves are red, or from trees, which grow in rocky situations. The bark are separated from the wood and dried in the sun. It is imported in bundles of about 12 inches long, tied together with strips of bamboo (Grieve, 1995).



1-branch, 2- flower, 3- umbel of flowers 4- fruit

Figure – 7 Cinnamon (grieve, 1995) .

It contains Euginol, O-methyl euginol, benzaldehyde, cinnamaldehyde, I-α-pinene, I-α and I-β-phellandrene, ρ-cymene, caryophyllene, benzyl benzoate, linalool, safrole, acetyleugenol, cinnamyl acetate, and cinnamyl alcohol.

The bark is acrid, bitter, sweet, aromatic, astringent, aphrodisiac, deodorant, stimulant, alexseteric, expectorant, febrifuge, diuretic, and carminative. It is useful in bronchitis, asthma, cephalalgia, odontalgia, cardiac diseases, diarrhea, uropathy, nausea, vomiting, flatulence, fever, halitosis, and restoring normal skin colour on the face.

Cinnamon oil is stomatic, carminative, emenagogue, and stypric, and is useful in anorexia, inflammations, stomachalgia, vitiated conditions of vita, odontalgia, vomiting and tubercular ulcers. (Prajapahi *et al.*, 2003)

2.1.8 Cardamom

Botanical name:- *Eletaria cardomomum Maton*

Family:- Zingiberaceae

A tall herbaceous perennial with subterranean branching root stock, 1.5- 5m in height; elliptic or lanceolate with sheathing base; flowers in panicles which are many for a plant arising from the base of the vegetative shoots, upright first and becoming prostrate, lip of the corolla white, streaked whit violet; Fruits triloculer, subglobose capsules, marked with very fine vertical ribs, seeds 15-20 for a pod, brownish black covered by a thin mucilaginous membrane.

The seeds containing palmetic and oleic as dominant fatty acids, besides linoleic and linolenic acids, along with α-tocopherol, desmosterol, and campesterol. 1, 8- Cineole, gives a harsh 'eucalyptol' smell to the oil if present in high proportions. α- pinene, β-pinene, α- terpinene, α- terpeniol α- terpinylacetate, terpinene-4-ol, borniol, nerol, nerolidol, geraniol, geranyl acetate, linalool and linalyl acetate.

The seeds are aromatic, acrid, sweet, cooling, stimulant, carminative, digestive, stomachic, diuretic, cardiotonic, abotifacient, alexeteric, expectorant, and tonic, and are useful in asthma, bronchitis, hemorrhoids, strangury, renal and vesical calculi, halitosis, cardiac disorders, anorexia, dyspepsia, gastropathy, hyperpiesia, burning sensation, debility and vitiated conditions of vata. Cardamom oil is used in several pharmaceutical preparations. (Prajapathi *et al.*, 2003).

2.1.9 Garcinia

Botanical name: - *Garcinia hanburyii*

Family:- Guttiferae

It is a very powerful drastic hydragogue, cathartic and bvery useful in dropsical conditions and to lower blood pressure.

2.1.10 Mustard, black

Botanical names:-*Brassica nigra and Sinapis nigra*

Family: - Cruciferae

It is an erect annual tree with 3 feet in height. The smooth, erect flattened pods, each provided with a short slender beak, contain about ten to twelve dark reddish-brown or black seeds, which are collected when ripe and dried.

1-whole plant, 2- flower, 3- pod, 4- seed

Figure- 8 Mustard black (Grieve ,1995).

The epidermal cells of the seed-coat contain much less mucilage than those of White Mustard seeds, but the cotyledons of Black Mustard seeds contain from 31 to 33 per cent of a fixed oil, which consists of the glycerides of Oleic, Stearic and Erucic or Brassic and Behenic acids. The seeds also contain the crystalline glucoside Sinigrin and the enzyme Myrosin. It is distilled from the seeds that have been deprived of most of the fixed oil and macerated in water for several hours, and contains from go to 99 per cent of the active principle, Allyl isothiocyanate, which is used as a counter irritant It is used as Irritant, stimulant, diuretic, emetic. Mustard is used in the form of poultices for external application near the seat of inward inflammation, chiefly in pneumonia, bronchitis and other diseases of the respiratory organs. It relieves congestion of various organs by drawing the blood to the surface, as in head affections, and is of service in the alleviation of neuralgia and other pains and spasms(Prajapathi *et al.*, 2003).

2.1.11 Lemon grass

Botanical name: - *cymbopogon citrates*(DC.) Staph

Family: - Poaceae

Perennial, densely tufted, aromatic grass; stems underground, short, whitish, or pale violet. Leaves in dance clusters, linear amplexicaul, rough – margined, glaucous green on both sides. Inflorasasnse in many branched panicles without stalks. All parts of the grass are lemon –flavoured.

The whole plant contains an essential oil consisting of citral, limonene, isopulegol, citronellic acid, and a- camphorene.

The entire plant possesses antiseptic, antifebrile and stomachic properties. It is used in treating coryza, influenza, and pyrexia. It is also prescribed against dyspepsia and vomiting and as a carminative, using three to four drops of essential oil, diluted in water. Used externally to treat eczema. The essential oil is used as an insecticide against mosquitoes and as a deodorant. (Prajapathi *et al.*,2003.).

2.1.12 Cloves

Botanical name: - *Eugenia caryophyllata* (THUMB), *Eugenia aromatica*

Family: - Myrtaceae

Volatile oil contains eugenol, acetyl euginol, menthol salcylate, pinene, vanilline, Gum, Tannins. The most stimulating and carminative of all aromatics; given in powder or infusion for nausea emesis, flatulence, languid indigestion and dyspepsia, and used chiefly to assist the action of other medicines. The medicinal properties reside in the volatile oil. The oil must be kept in dark bottles in a cool place. If distilled with water, salt must be added to raise the temperature of ebullition and the same Cloves must be distilled over and over again to get their full essence. The oil is frequently adulterated with fixed oil and oil of Pimento and Copaiba. As a local irritant it stimulates peristalsis. It is a strong germicide, a powerful antiseptic; a feeble local anesthetic applied to decayed teeth, and has been used with success as a stimulating expectorant in phthisis and bronchial troubles. Fresh infusion of Cloves contains astringent matter as well as the volatile oil. The infusion and Clove water are good vehicles for alkalies and aromatics.

2.1.13 Chillies

Botanical name: - *Capsicum minimum*

Family: - Solanaceae

Perennial erect herb or small subs herb to 2 m in high. Leaves alternate, petiolate, simple, and ovate and pointed with entire margins. Flowers born usually singly in leaf and branch axils., white to violet, five- parted. Fruit a dry to fleshy red elongated berry with numerous flattened seed, which are hot tasting.

Ascorbic acid, cafferic acid, caproic acid, capsaicin, dihydrocapsaicin, cinnamic acid, para- coumaric acid, ferulic acid, mevalonic acid, pyrazine derivatives, capsiceol, kaempferol derivatives, lipids. Vitamins, A 7 B, capsicin, Volatile and fatty oils, pentosans, pectins, .Acetic, butyric, and isobutyric acids.

Medicinal actions and uses: - It is used as a remedy for diseases of the skin, tuberculosis, mild conjunctivitis and jounce. Also uses to treat boils, abscesses and wounds. Used to treat inflammation and cough. Coconut oil mixed with the crushed leaves is applied to boils the fruit contains a strong stimulant which causes a sensation of warmth when applied to the skin. The stronger doses, it causes a burning sensation without blistering. When taken internally it causes a sensation of warmth without any narcotic effect (Prajapathi *et al.*, 2003).

2.1.15 Curry leaves

Botanical name: - *Murraya koenigii* (L.) Spereng.

Family: - Rutaceae

An aromatic sherb or small tree; leaves pinnate, leaflets mostly ovate, crenate-dentate; flowers white in crombose cymes; berries perpolish black.The major aroma constituents in the oil are b- caryophylline, b- gurjunene, b- elemene and b-phellandrene. The leaves are extensively used for flavouring curries, chutneys, soups, pickles (Prajapathi *et. al.*, 2003).

2.2 The separation of immature seeds and foreign matter from spice seeds

This is done by the gravity separation machines called bhuler machines. The separation is done by air flows and with the density of the specific seed type and the foreign matter like stones, twigs, earth and immature seeds.

2.3. The elimination of the insects.

The elimination of the insects is done by fumigation in the industry. In big scale industry they use special types of fumigation chambers that use liquid of gaseous fumigants like phospene or hydrogen cyanide, 1-2 Dibormoehtene, 2- Phenylphenol, sodium orthophenyl phenol.

For the small scale industries there are solid fumigants consist of Aluminum phospide. They simply cover the bulk with a tarpaulin and put some Aluminum phospide tablets. When the tablets absorb moisture from the atmosphere they release phaspene gas that act as a fumigant.

2.4. The grinding

Grinding reduce the size of solid materials by mechanical action, dividing them into smaller particles. Perhaps the most extensive application of grinding in the food industry is in the milling of grains to make flour, but it is used in many other processes, such as in the grinding of corn for manufacture of corn starch, the grinding of spices and the milling of dried foods, such as vegetables.

In the grinding process, materials are reduced in size by fracturing them. The mechanism of fracture is not fully understood, but in the process, the material is stressed by the action of mechanical moving parts in the grinding machine and initially the stress is absorbed internally by the material as strain energy. When the local strain energy exceeds a critical level, which is a function of the material, fracture occurs along lines of weakness and the stored energy is released. Some of the energy is taken up in the creation of new surface, but the greater part of it is dissipated as heat. Time also plays a part in the fracturing process and it appears that material will fracture at lower stress concentrations if these can be maintained for longer periods. Grinding is, therefore, achieved by mechanical stress followed by rupture and the

energy required depends upon the hardness of the material and also upon the tendency of the material to crack - its friability.

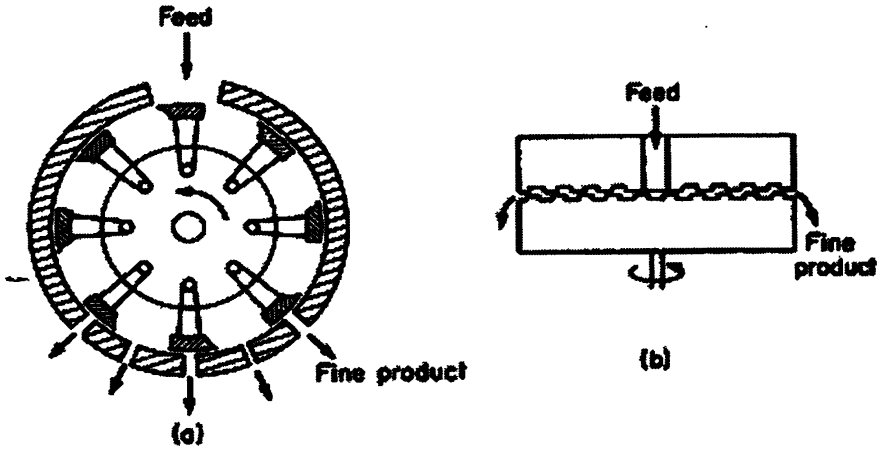
The force applied may be compression, impact, or shear, and both the magnitude of the force and the time of application affect the extent of grinding achieved. For efficient grinding, the energy applied to the material should exceed, by as small a margin as possible, the minimum energy needed to rupture the material. Excess energy is lost as heat and this loss should be kept as low as practicable.

As we are grinding spices there are two types of mills are used in Sri Lanka they are special hammer mills called masala mills and plate mills. The type of the grinding method is important, because by this two method the generation of heat while grinding is different. This is important because that the volatile oils are starting evaporation at 30°C. The effect of the mills on the volatile oil content can be measured by grinding the same blend of spices in two mills separately and then the remaining volatile oil content is measured by the steam distillation method.

2.4.1. Hammer mills

In a hammer mill, swinging hammerheads are attached to a rotor that rotates at high speed inside a hardened casing. The principle is illustrated in Fig. 11.2(a).

The material is crushed and pulverized between the hammers and the casing and remains in the mill until it is fine enough to pass through a screen which forms the bottom of the casing. Both brittle and fibrous materials can be handled in hammer mills, though with fibrous material, projecting sections on the casing may be used to give a cutting action. (Earle and Earle, 1983)



Hammer mill **Plate mill**

Figure 9 plate and hammer mill (Earle and Earle 1983)

2.4.2. Plate mills

In plate mills the material is fed between two circular plates, one of them fixed and the other rotating. The feed comes in near the axis of rotation and is sheared and crushed as it makes its way to the edge of the plates, see Fig. 11.2(b). The plates can be mounted horizontally as in the traditional Buhr stone used for grinding corn, which has a fluted surface on the plates. The plates can be mounted vertically also. Developments of the plate mill have led to the colloid mill, which uses very fine clearances and very high speeds to produce particles of colloidal dimensions.

2.5. Packing methods of the processed spices

2.5.1. Low density polyethylene (LDPE)

LDPE accounts for the biggest proportion of the plastics used in packaging. One of the reasons for it's wide spread use is its versality. It can be extrude in to film, blown in to bottles, injection moulded in to colours and dispensers of all sorts, extrude as a coating on paper, aluminium foil or cellulose film, and made in to large tanks and other containers by rotational casting.

Low density polyethylene is relatively inert chemically and almost insoluble in all solvents at room temperature. Some softening and swelling can occur, with hydrocarbons and chlorinated hydrocarbons. Permeability is low for water vapour but many vapours and essential oils pass rapidly through low density polyethylene. Its permeability to oxygen is fairly high. So where oxidation is like to be a problem, low density polyethylene is not suitable for packing spices. (Graf and Gaguy ,1998)

2.5.2. Nylons *(polyamides)*

Nylons were first prepared by the condensation of di-acids with di-amines and were characterized by a number derived from the number of carbon atoms in the parent compound. Thus the nylon 6, 6 is the condensation product of Adific acid and Hexamethylene diamine, both of wich have six carbon atoms in the molecule. Later methods were developed for the manufacture of nylon by the condensation of certain amino acids. Nylons prepared by this route are characterized by a single number of derived from the number of carbon atoms in parent amino acid.

In general, Nylons are tough materials with high tensile strength and good resistance to abrasion. They also have high softening points and can withstand steam sterilization (up to about 140°C) and dry heat to even higher temperatures. They retain there flexibility at low temperatures so that they have a vide range of temperature of

use. Nylons are slightly hydroscopic and there mechanical properties are altered somewhat by water absorption. The effect is not permanent and the properties recovered on drying.

Nylons have fairly high moisture vapour permeabilitys but are very good gas barriors, and Nylon films are thus used in laminates for vacuum packaging. Nylons arte good barriers to odour.

Chemically nylons are resistant to weak acids but are attacked by concentrated mineral acids. They are resistant to alkalis, even at high concentrations, and are particularly resistant to organic solvents, oils and greases.

The transparency of nylon films is excellent, especially when biaxially oriented, but there gloss is only fair although this too is improved by orientation. (Frank and Heather, 1992)

2.5.3. Polyesters

The polyethylene terephthalate (PET) are undoubtedly the most important of these materials. They can be used in film form for boil- in – the - bag and other applications, but must be oriented to develop the full tensile strength. They are not easily heat – sealable and there for often laminated to polyethylene film for bag-making purposes. Since PET was used in the late 1970s to produce a clear lightweight shatter resistant beverage bottle, it has probably grown further than any other plastic for this use.

(Frank and Heather, 1992)

2.5.4. Testing the effectiveness of the packaging materials.

For this test the spice mix have to keep in different packages for a longer period. The content the packing date should be same. Then after the spice powder is steam distilled and the content of remaining volatile oils should be obtained and by comparison the best packing material can be found. The best packaging would retain the highest content of volatile oils. (Frank and Heather, 1992)

2.6. Sensory evaluations

A sensory evaluation is made by the sense of taste, smell, colours, touch, and hearing when food is eating. The complex sensation that results from the interaction of our

senses is used to measure food quality in programs for quality control and new product development.

Sensory evaluation is also a science of measurement. Like other analytical test procedures, sensory evaluation is concerned with precision, accuracy, sensitivity, and avoids false positive results. A good sensory test will minimize errors in measurement and errors in conclusions and decisions.

The sensory tests provide useful information about the human perception of the product changes due to ingredients, processing, packaging, shelf life
(Lawlies and Heymann, 1998).

2.6.1. Types of tests

Sensory evaluation comprises a set of test method with guidelines and established techniques for product presentation and well defined response.

Three primary kinds of sensory tests focus on existence of overall differences among products (Discrimination test). And specification of attributes (Descriptive analysis) and measuring consumer likes and dislikes (Alternative or hedonic testing) the discrimination and descriptive procedures require good experimental control and maximization of taste and precision. Effective tests, on the other hand, required use of representative consumers of the product and test conditions that enable generation to how products are experienced by the real world. (Lawlies and Heymann, 1998).

2.6.2. Hedonic test

Hedonic test used in the food industries to determine acceptance of food the major classes of sensory tests are those that attempt to quantify the degree of the liking or disliking of a product , called hedonic scale or affective test method. This method provided a balanced 9 – point scale for liking with a cantered neutral category and attempted to produce scale point labels with adverbs that represented psychologically equals steps of changes in hedonic tone. In other words, it was a scale with be amendable to statistical analysis. . (Lawlies and Heymann, 1998).

(1) Flavor can devide in to three catogories

taste

odour

feeling

(2) Appearanse

(3) texture

2.6.4. Sensory panel and panellist

Panel

A group of people that comprises a test population chosen for specific characteristic such as product usage, sensory quality or willingness to participate in repeated sensory test.

Panellist

Generally a participant in sensory evaluation panellist cannot participant as a member of a group that is often listed on more than one location (Larmond, 1987).

2.7. The chemical analysis methods for the spice

2.7.1 Determination of moisture

Bidwell and starling troluene distillation volumetric method

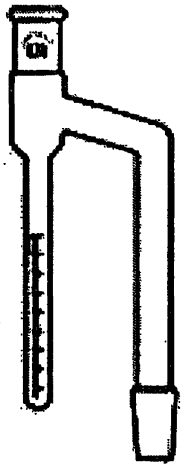


Figure: 10 Bidwell and Starling distillation unit

As originally devised at the U.S. Food Administration laboratory the method was applied to a variety of products including molasses, jam, honey, butter, flour, and dried milk.

- The bottom of the distillation flask is cowered with the dry sand and 75ml of *troluene* is added.
- First when the troluene flow is refluxing a known volume of water is added to the distillation flask
- The reading of the graduated arm is taken
- Then a known weight of the sample is introduced in to the flask
- The new reading is taken.
- The results were calculated using the reading and the reading of the bidwell apparatus. (Winton and Winton, 2001).

2.7.2. Protein analysis method

In the kjeldhal protein analysis method the parameter that measure is the nitrogen content of the food sample. In this method all the nitrogen is changed in to ammonium sulphate by adding concentrated Sulphuric acid and a catalyst ($CuSO_4$ and $Se\ O_2$) the reaction takes place as below.

$$\text{Food sample} \xrightarrow[\text{Cartelist + heat}]{\text{Conc.: sulphuric acid}} (NH_4)_2SO_4$$

Then the digested sample is neutralized with a alkaline and distilled in to a boric acid solution

Here the reactions occur as below

$$(NH_4)_2SO_4 + 2\ NaOH \longrightarrow Na_2SO_4 + 2\ NH_3 + 2\ H_2O$$

When the distillation is happed

$$NH_3 + H_3BO_3 \longrightarrow NH_4 + H_2BO_3^-$$

$$H_2BO_3^- + HCl \longrightarrow H_3BO_3$$

When the titration is done with acid and the results were taken.(Winton and Winton, 2001).

2.7.3 Determination of ash

For this the muffle furnace method is used here the sample is first weight in an analytical balance in a ceramic cup that is the weight is known. Then the sample is ignited in the heater and after t turned in to char it is put in the muffle furnance set to 500 ^{0}C to 600 ^{0}C temperature until a constant weight is obtained . by converting all the carbon to gases the organic matters are removed.

CHAPTER 03

MAREIALS AND METHODOLOGY

3.1. Formulation of the product

3.1.1. Materials

- Coriander powder
- Cumin powder
- Fennel powder
- Cinnamon powder
- Clove powder
- Ginger powder
- Fenugreek powder
- Turmeric powder
- Cardamom powder
- Curry leaves powder
- Chili powder
- Rumpe powder
- Garcinia powder

3.1.2. Method

Ground spice powder was taken and three curry powder formulas were developed by changing the Coriander proportion the flavour indices were calculated by taking the flavour profile.

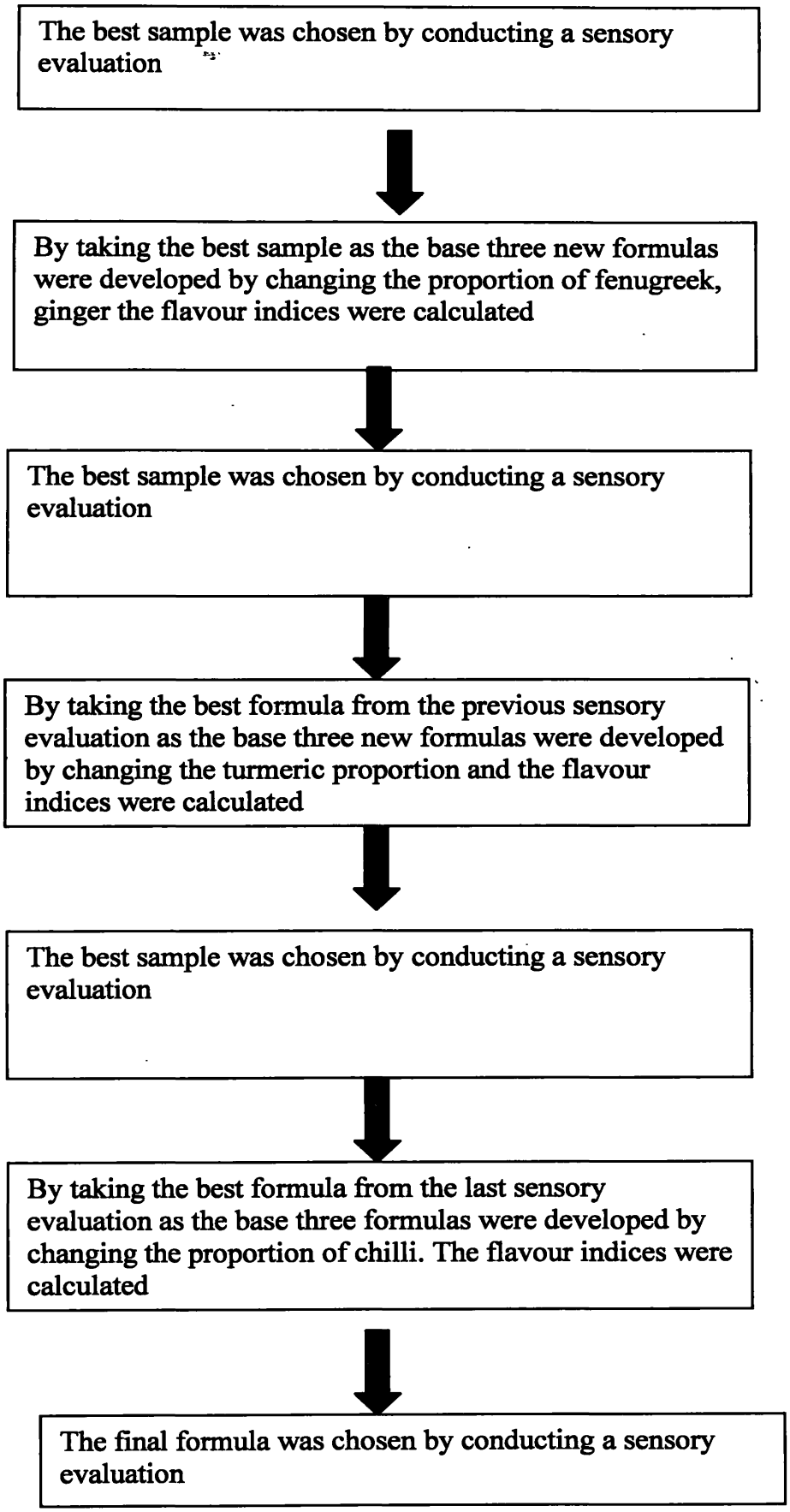
↓

The best sample was chosen by conducting a sensory evaluation

↓

By keeping the other ingredients proportion as a constant from the last best sample, three new formulas were developed by changing the proportions of the cumin and fennel. The flavour indices were calculated

↓



3.1.2.1. Finding the effect of coriander proportion on sensory parameters.

The proportion of coriander was 40 % and the

The sample number 359

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	40	230	9200	33.82912614
cumin	c	25.4	290	7366	27.08536339
fennel	b	25.4	330	8382	30.82127558
cinnamon	b	0.3	460	138	0.507436892
clove	c	0.3	560	168	0.61774926
ginger	d	0.3	475	142.5	0.523983747
fenugreek	c	2	200	400	1.470831571
turmeric	c	3	400	1200	4.412494714
cardamom	b	0.3	125	37.5	0.13789046
curry leaves	b	1.7	95	161.5	0.593848247
				27195.5	

Table . 3– 1 formula 40% coriander

Profile: - a. Light sweet top notes - 33.82%

b. Medium aromatic notes - 32.04%

c. Full – bodied spicy notes – 30.62%

d. Pungent spicy notes - 0.52 %

The proportion of coriander was 60%

The sample number 514

Table. -3.2 formula, 60% coriander

	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	53.91572737
Cumin	c	15.4	290	4466	17.4483796
Fennel	b	15.4	330	5082	19.85505265
cinnamon	b	0.3	460	138	0.539157274
Clove	c	0.3	560	168	0.656365377
Ginger	d	0.3	475	142.5	0.556738489
fenugreek	c	2	200	400	1.562774706
Turmeric	c	3	400	1200	4.688324119
cardamom	b	0.3	125	37.5	0.146510129
curry leaves	b	1.7	95	161.5	0.630970288
				25595.5	

Profile: - a. Light sweet top notes -53.91%

b. Medium aromatic notes -21.15%

c. Full – bodied spicy notes-24.25%

d. Pungent spicy notes - 0.55%

The proportion of coriander was 80%

The sample number 188

Table – 3. 3 formula , 80% coriander

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	80	230	18400	76.68104436
Cumin	c	5.4	290	1566	6.526223667
Fennel	b	5.4	330	1782	7.426392449
cinnamon	b	0.3	460	138	0.575107833
Clove	c	0.3	560	168	0.700131275
Ginger	d	0.3	475	142.5	0.593861349
fenugreek	c	2	200	400	1.666979225
Turmeric	c	3	400	1200	5.000937676
cardamom	b	0.3	125	37.5	0.156279302
curry leaves	b	1.7	95	161.5	0.673042862
				23995.5	

Profile: - a. Light sweet top notes -76.68%

b. Medium aromatic notes - 8.74%

c. Full – bodied spicy notes-13.88%

d. Pungent spicy notes - 0.59%

After analyzing the data the sample statistically by the krushkal Wallis test it shows that the 514 sample shows the best from taste, colour, smell, appearance and overall acceptance.

3.1.2.2. Finding the effect of cumin and fennel proportion on sensory parameters.

The proportion of the cumin and fennel was changed

The cumin = 15.4% and fennel= 15.4%

The sample number 238

Table – 3. 4 formula , 15.4% cumin and 15.4% fennel

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	53.91572737
cumin	c	15.4	290	4466	17.4483796
fennel	b	15.4	330	5082	19.85505265
cinnamon	b	0.3	460	138	0.539157274
clove	c	0.3	560	168	0.656365377
ginger	d	0.3	475	142.5	0.556738489
fenugreek	c	2	200	400	1.562774706
turmeric	c	3	400	1200	4.688324119
cardamom	b	0.3	125	37.5	0.146510129
curry leaves	b	1.7	95	161.5	0.630970288
Total				25595.5	

Profile: - a. Light sweet top notes -53.91%

b. Medium aromatic notes -25.61%

c. Full – bodied spicy notes -24.33%

d. Pungent spicy notes - 0.53%

The cumin proportion was

Cumin= 20% fennel= 10.8%

Sample number = 567

Table – 3. 5 formula, cumin 20% and fennel 10.8%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	54.30612124
cumin	c	20	290	5800	22.82431183
fennel	b	10.8	330	3564	14.0251461
cinnamon	b	0.3	460	138	0.543061212
clove	c	0.3	560	168	0.661117998
ginger	d	0.3	475	142.5	0.56076973
fenugreek	c	2	200	400	1.574090471
turmeric	c	3	400	1200	4.722271413
cardamom	b	0.3	125	37.5	0.147570982
curry leaves	b	1.7	95	161.5	0.635539028
Total				25411.5	

Profile: - a. Light sweet top notes -54.30%

b. Medium aromatic notes -15.33%

c. Full – bodied spicy notes -29.77%

d. Pungent spicy notes - 0.56%

The cumin =10.8% fennel= 20%

The sample number = 452

Table – 3. 6 formula, cumin 10.8% and fennel 20%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	53.53090634
cumin	c	10.8	290	3132	12.14918831
fennel	b	20	330	6600	25.60173781
cinnamon	b	0.3	460	138	0.535309063
clove	c	0.3	560	168	0.651680599
ginger	d	0.3	475	142.5	0.552764794
fenugreek	c	2	200	400	1.551620474
turmeric	c	3	400	1200	4.654861421
cardamom	b	0.3	125	37.5	0.145464419
curry leaves	b	1.7	95	161.5	0.626466766
Total				25779.5	

Profile: - a. Light sweet top notes -53.53%

b. Medium aromatic notes -26.89%

c. Full – bodied spicy notes -18.99%

d. Pungent spicy notes - 0.55%

After analyzing the data the sample statistically by the krushkal Wallis test it shows that the 452 sample shows the best from taste, colour, appearance and overall acceptance. But the smells for the three samples are significant.

3.1.2.3. Finding the effect of fenugreek and ginger proportion on sensory parameters.

Fenugreek 6% and ginger 0.9%

Sample number 760

Table –3. 7 formula, fenugreek 6% and ginger 0.9%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	51.36890692
cumin	c	10.8	290	3132	11.65850844
fennel	b	20	330	6600	24.56773809
cinnamon	b	0.3	460	138	0.513689069
clove	c	0.3	560	168	0.625360606
ginger	d	0.9	475	427.5	1.591319399
fenugreek	c	6	200	1200	4.466861471
turmeric	c	3	400	1200	4.466861471
cardamom	b	0.3	125	37.5	0.139589421
curry leaves	b	1.7	95	161.5	0.601165106
Total				26864.5	

Profile: - a. Light sweet top notes -51.36%

b. Medium aromatic notes -25.81%

c. Full – bodied spicy notes-21.19%

d. Pungent spicy notes - 1.59%

Fenugreek 2% and Ginger 0.3%

Sample number 245

Table –3. 8 formula, fenugreek 2% and ginger 0.3%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	53.53090634
cumin	c	10.8	290	3132	12.14918831
fennel	b	20	330	6600	25.60173781
cinnamon	b	0.3	460	138	0.535309063
clove	c	0.3	560	168	0.651680599
ginger	d	0.3	475	142.5	0.552764794
fenugreek	c	2	200	400	1.551620474
turmeric	c	3	400	1200	4.654861421
cardamom	b	0.3	125	37.5	0.145464419
curry leaves	b	1.7	95	161.5	0.626466766
Total				25779.5	

Profile: - a. Light sweet top notes - 53.53%

b. Medium aromatic notes -26.89%

c. Full – bodied spicy notes-18.99%

d. Pungent spicy notes - 0.55%

Fenugreek 4% and Ginger 0.6%

The sample number 456

Table – 3. 9 formula, fenugreek 4% and ginger 0.6%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	52.42762708
cumin	c	10.8	290	3132	11.89879189
fennel	b	20	330	6600	25.07408252
cinnamon	b	0.3	460	138	0.524276271
clove	c	0.3	560	168	0.638249373
ginger	d	0.6	475	285	1.082744472
fenugreek	c	4	200	800	3.039282729
turmeric	c	3	400	1200	4.558924094
cardamom	b	0.3	125	37.5	0.142466378
curry leaves	b	1.7	95	161.5	0.613555201
Total				26322	

Profile: - a. Light sweet top notes -52.42%

b. Medium aromatic notes -26.34%

c. Full – bodied spicy notes-20.10%

d. Pungent spicy notes - 1.08%

After analyzing the data the sample statistically by the krushkal Wallis test it shows that the 760sample shows the best from taste, colour and overall acceptance. But the smells for the three samples are significant. The sample 245 got the best appearance. But when considering to the other facts 760 was taken as the best sample

3.1.2.4. Finding the effect of turmeric proportion on sensory parameters.

The proportion of turmeric was changed.

The turmeric proportion was 3%

The sample number: - 122

Table – 3. 10 formula, turmeric 3%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	60	230	13800	51.36890692
cumin	c	10.8	290	3132	11.65850844
fennel	b	20	330	6600	24.56773809
cinnamon	b	0.3	460	138	0.513689069
clove	c	0.3	560	168	0.625360606
ginger	d	0.9	475	427.5	1.591319399
fenugreek	c	6	200	1200	4.466861471
turmeric	c	3	400	1200	4.466861471
cardamom	b	0.3	125	37.5	0.139589421
curry leaves	b	1.7	95	161.5	0.601165106
Total				26864.5	

Profile: - a. Light sweet top notes - 51.36%

b. Medium aromatic notes -25.80%

c. Full – bodied spicy notes – 21.19%

d. Pungent spicy notes - 01.59%

The proportion of turmeric = 5%

Sample number 367

Table – 3, 11 formula, turmeric 5%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	58	230	13340	50.52169138
cumin	c	10.8	290	3132	11.8616145
fennel	b	20	330	6600	24.99573936
cinnamon	b	0.3	460	138	0.522638187
clove	c	0.3	560	168	0.636255184
ginger	d	0.9	475	427.5	1.619042209
fenugreek	c	6	200	1200	4.544679884
turmeric	c	5	400	1200	4.544679884
cardamom	b	0.3	125	37.5	0.142021246
curry leaves	b	1.7	95	161.5	0.611638168
Total				26404.5	

Profile: - a. Light sweet top notes -50.52%

b. Medium aromatic notes -26.26%

c. Full – bodied spicy notes -21.59%

d. Pungent spicy notes -01.61%

The third sample

Proportion of turmeric is = 7%

The sample number 587

Table – 3. 12 formula, turmeric 7%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	56	230	12880	49.64443331
cumin	c	10.8	290	3132	12.07192276
fennel	b	20	330	6600	25.43891769
cinnamon	b	0.3	460	138	0.531904643
clove	c	0.3	560	168	0.647536087
ginger	d	0.9	475	427.5	1.647748078
fenugreek	c	6	200	1200	4.625257762
turmeric	c	7	400	1200	4.625257762
cardamom	b	0.3	125	37.5	0.144539305
curry leaves	b	1.7	95	161.5	0.622482607
Total				25944.5	

Profile: - a. Light sweet top notes -49.94%

b. Medium aromatic notes -26.72%

c. Full – bodied spicy notes -21.95%

d. Pungent spicy notes -01.64%

After analyzing the data the sample statistically by the krushkal Wallis test it shows that the 578sample shows the best from taste, colour, smell, appearance and overall acceptance. For the last step of the formulation the sample 367 was taken.

3.1.2.5. Finding the effect of chilli proportion on sensory parameters.

The proportion of the chilli was changed in order to find out the best chilli proportion that he consumers would prefer.

The three proportions were taken as

5%, 8%, 11% for that incensement the proportion of Coriander was changed to get the formulated meet the correct percentages.

The first sample proportion of chilli was: 5%

Sample number 768

Table –3. 13 formula, Chillies 5%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	58	230	13340	42.47798882
cumin	c	10.8	290	3132	9.973093028
fennel	b	20	330	6600	21.01609642
cinnamon	b	0.3	460	138	0.439427471
clove	c	0.3	560	168	0.534955182
ginger	d	0.9	475	427.5	1.361269882
fenugreek	c	6	200	1200	3.82110844
turmeric	c	5	400	1200	3.82110844
cardamom	b	0.3	125	37.5	0.119409639
chillies	d	5	1000	5000	15.92128517
curry leaves	b	1.7	95	161.5	0.514257511
total				31404.5	

Profile: - a. Light sweet top notes - 42.47%

b. Medium aromatic notes - 22.08%

c. Full – bodied spicy notes - 18.14%

d. Pungent spicy notes - 15.92%

The second sample chilli propotion was: 8%

Sample number: 521

Table – 3. 14 formula, chillies 8

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	50	230	11500	35.31452963
cumin	c	10.8	290	3132	9.617835373
fennel	b	20	330	6600	20.26746918
cinnamon	b	0.3	460	138	0.423774356
clove	c	0.3	560	168	0.515899215
ginger	d	0.9	475	427.5	1.312779253
fenugreek	c	6	200	1200	3.684994396
turmeric	c	5	400	1200	3.684994396
cardamom	b	0.3	125	37.5	0.115156075
chillies	d	8	1000	8000	24.5666293
curry leaves	b	1.7	95	161.5	0.495938829
Total				32564.5	

Profile: - a. Light sweet top notes -35.31%

b. Medium aromatic notes - 21.28%

c. Full – bodied spicy notes - 17.48%

d. Pungent spicy notes - 25.87%

Proportion of chilli = 11%

Sample number= 895

Table – 3. 15 formula, chillies 11%

The spice	Type	% by weight	flavour index	flavour contribution	% flavour contribution
coriander	a	48	230	11040	31.44895954
cumin	c	10.8	290	3132	8.921933086
fennel	b	20	330	6600	18.80100842
cinnamon	b	0.3	460	138	0.393111994
clove	c	0.3	560	168	0.478571123
ginger	d	0.9	475	427.5	1.217792591
fenugreek	c	6	200	1200	3.418365167
turmeric	c	5	400	1200	3.418365167
cardamom	b	0.3	125	37.5	0.106823911
chillies	d	11	1000	11000	31.33501403
curry leaves	b	1.7	95	161.5	0.460054979
Total				35104.5	

Profile: - a. Light sweet top notes -31.44%

b. Medium aromatic notes -19.76%

c. Full – bodied spicy notes-16.21%

d. Pungent spicy notes -32.55%

3.1.2.6. The sensory evaluation

Materials

Potatoes, coconut milk powder, water, salt, samples

Methodology

Potatoes were cooked by adding same amounts of all ingredients and same amounts of the curry mix samples and cooked the samples then the samples were kept for the sensory evaluation to the selected panel.

The samples were tested by giving them the 9 – scale hedonic table

Results were analysed by the krushkal – wallis test by the Mini tab statistical analysis package.

3.2. Microbiological evaluation

3.2.1Total plate count

3.2.1.1. Materials and chemicals

- Plate count agar (PCA)
- Maximum recovery diluent (MRD)
- 7 Petri dishes
- 2- culture bottles
- 2- conical flasks
- 3- test tubes
- 1- funnel
- 1- wathman no 1 filter paper
- 3- 1ml pipettes
- 1- 10 ml pipettes
- A laboratory balance

3.2.1.2. Method:-

- The glass ware were wrapped with news paper and sterilized for 30 minutes at 121°C at 15 atm
- They were kept overnight to cool.
- 150 ml of MRD was prepared by adding distilled water to it and dissolved it in a conical flask.
- 90 ml of MRD was poured in to a conical flask and opening was plugged with cotton wool and wrapped with aluminium foil.
- 9 ml of MRD was poured each of to two test tubes and plugged with cotton wool.
- The plate count agar was prepared by adding 9.1g in to 150 ml of distilled water and poured in to the culture bottle.
- The two MRD tubes, the 90ml MRD conical flask and the plate count agar was sterilized in a autoclave sterilizer for 15 minutes at 121 °C at 15 bar.
- The MRD and the culture media were led to cool in the normal room temperature.
- 10 g of curry powder mix was added to the 90 ml MRD solution and mixed thoroughly. Then it was filtered through the sterilized filter paper and the filtrate was collected to the remaining test tube. It was labelled as 10^{-1} dilution.
- 1 ml of 10^{-1} was taken from a one ml pipette in to a sterilized 9 ml MRD tube and the 10^{-2} dilution was prepared and labelled as 10^{-2} dilution. The pipette was also labelled as 10^{-2} for the inoculation step
- 1 ml of the10^{-2} dilution was taken from another pipette and put in to sterilized 9ml MRD tube and the 10^{-3}dilution was made. The pipette was kept for the inoculation step.
- The wraps of the Petri plates were removed and then each of two Petri plates were introduced with 1ml of 10^{-1} dilution then labelled as 10^{-1} dilution.
- Another two Petri dishes were taken and they were introduced with1 ml of 10^{-2} dilution for each plate.
- 2 new Petri plates each one were introduced with 1 ml of 10^{-3} dilution and the plates were labelled as 10^{-3}.
- Then after 15ml of plate count agar was introduced in to the Petri plates in a sterile atmosphere. Then they were shaken to mix with the inoculums.

- The remaining Petri dish was filled with 15ml of culture media and labelled as the blank test.
- When the agar is set the Petri dishes were inverted and stored in an incubator set to 25°C ± 1 for three to five days.
- Results were observed by counting the number of colonies in the plate and the microbial quality of the sample was calculated using the formula below.

$$N = \frac{\sum C}{(N * 0.1 + N * 0.01 + N * 0.001)\, d}$$

3.2.2. Yeast and mould count

3.2.2.1. Materials and chemicals

- Potato dextrose agar (PDA)
- Maximum recovery diluent (MRD)
- 7 Petri dishes
- 2- culture bottles
- 2- conical flasks
- 3- test tubes
- 1- funnel
- 1- wathman no 1 filter paper
- 3- 1 ml pipettes
- 1- 10 ml pipettes
- Clorompenicol
- A laboratory balance

3.2.2.2. Method:-

- The glass ware were wrapped with news paper and sterilized for 30 minutes at 121°C
  at 15 atm.

- They were kept overnight to cool.
- 150 ml of MRD was prepared by adding distilled water to it and dissolved it in a conical flask.
- 90 ml of MRD was poured in to a conical flask and opening was plugged with cotton wool and wrapped with aluminium foil.
- 9 ml of MRD was poured each of to two test tubes and plugged with cotton wool.
- The potato dextrose agar was prepared by adding 9.1g in to 150 ml of distilled water and poured in to the culture bottle.
- The two MRD tubes, the 90ml MRD conical flask and the plate count agar was sterilized in a autoclave sterilizer for 15 minutes at 121 °C at 15 bar.
- The MRD and the culture media were led to cool in the normal room temperature.
- 10 g of curry powder mix was added to the 90 ml MRD solution and mixed thoroughly. Then it was filtered through the sterilized filter paper and the filtrate was collected to the remaining test tube. It was labelled as 10^{-1} dilution.
- 1 ml of 10^{-1} was taken from a one ml pipette in to a sterilized 9 ml MRD tube and the 10^{-2} dilution was prepared and labelled as 10^{-2} dilution. The pipette was also labelled as 10^{-2} for the inoculation step
- 1 ml of the10^{-2} dilutions was taken from another pipette and put in to sterilized 9ml MRD tube and the 10^{-3}dilution was made. The pipette was kept for the inoculation step.
- The wraps of the Petri plates were removed and then each of two Petri plates were introduced with 1ml of 10^{-1} dilution then labelled as 10^{-1} dilution.
- Another two Petri dishes were taken and they were introduced with1 ml of 10^{-2} dilution for each plate.
- 2 new Petri plates each one were introduced with 1 ml of 10^{-3} dilution and the plates were labelled as 10^{-3}
- Then after the cooled PDA was introduced with a minute amount of Chlorompenicol to stop the growth of bacteria in the Petri dishes 15ml of plate count agar was introduced in to the Petri plates in a sterile atmosphere. Then they were shaken to mix with the inoculums.

- The remaining Petri dish was filled with 15ml of culture media and labelled as the blank test.
- When the agar is set the Petri dishes were inverted and stored in an incubator set to 26°C ± 1 for three to five days.
- Results were observed by counting the number of colonies in the plate and the microbial quality of the sample was calculated using the formula below.

$$N = \frac{\sum C}{(N * 0.1 + N * 0.01 + N * 0.001)\, d}$$

3.3. Proximate analysis

3.3.1. Bidwell and starlin toluene distillation moisture analysis method.

3.3.1.1. Glassware and apparatus

- Bidwell and starlin apparatus
- 100 ml measuring cylinder
- 250 ml beaker

3.3.1.2. Reagents

- Amyl alcohol , Toluene

3.3.1.3. Method

- The glassware were thoroughly cleaned and dried in the hot air oven
- 75 ml of Amyl alcohol and 150 ml of Toluene were mixed together to prepare the distillation solution.
- 50 ml of the solution and few fumic stones were flask.
- The calibrated arm was fixed to the boiling flask and the solution was boiled until the graduated arm get in to constant.
- 2 ml of water was added to the flask and boiled until a constant volume is obtained.
- Then 2 g of sample was added to the flask and boiled until a constant volume is obtained.
- The moisture percentage was calculated.

3.3.2. Determination of total fat content

3.3.2.1. Reagents and glassware

Hydrochloric acid, ether, ethanol, separation funnel, beaker (100 ml)

3.3.2.2. Method

- 2.00 g of the sample was placed in the beaker.
- 2 ml of 95% ethanol and 10 lm of HCl (which is prepared by adding 25 ml of concentrated HCl and 1.0 ml of water) were added to the beaker.
- The content was mixed thoroughly.
- It was placed in a water bath (70°C to 80 °C) for about 30 minutes .and then it was removed from the water bath and allowed it to cool in the atmosphere.
- Then 10 ml of ethanol was added to the beaker and then the mixture was poured in to the separation funnel.
- The beaker was washed with 25 ml of ether in three portions and added to the separation funnel.
- The funnel was fixed with a stopper and shaken vigorously for about few minutes. Then another 25 ml of ether was added again and shaken vigorously.
- The separation funnel was led to stand to separate a clear layer of ether.
- The upper ether part was separated into previously weighed flask.
- It was dried in a rotary evaporator. Then the weight of the flask was obtained.
- The percentage of fat was obtained by the formula below,

$$\% \text{ of fat} = \frac{\text{Weight of fat} * 100}{\text{Weight of sample}}$$

3.3.3. Determination of fibre content

3.3.3.1. Reagents

Ethanol, sodium hydroxide, conc. sulphuric acid,

3.3.3.2. Apparatus

Round bottom flask, reflux condenser, sintered crucible, asbestos wool, desicator, heating mantel, electronic balance and suction pump.

3.3.3.3. Method

- Fat free sample was taken to a 400 ml beaker, which has been previously marked at 200 ml level.
- 50 ml of 5% sulphuric acid was added and distilled water was added to the 200 ml level.
- The contents were boiled for 13 minutes while stirring with a rubber tipped glass rod.
- The 200 ml volume was kept constantly by adding hot water from time to time.
- The hot solution was filtered through a Buchner funnel under suction.
- The residue was transferred into a beaker with a jet of hot water.
- The residue was washed with hot water till the filtrate is free of acids.
- Residue was transferred to the same beaker by scraping off with a spatula and hot water
- 50 ml of 5% sodium hydroxide solution was added to it and diluted with distilled water up to 200 ml level.
- The content was boiled for 30 minutes while stirring with a glass rod.
- It was filtered under suction in Buchner funnel.
- The residue was washed few times with hot water and then with 1% HCl .then it was washed again with boiling water until filtrate is free of acids.
- The content was allowed to dry under suction.
- Then the residue was washed with 2 portions of 10 ml 95% ethanol and the content was transferred to a porcelain dish weighed previously.
- The content was kept in an oven at 105°C until it gets a constant weight.
- The dish was weighed with the content.
- The content in the dish was igniting at 600+-20 °C and it was kept in a muffle furnance until a constant weight is gained.
- The crude fibre % was calculated by the formula below,

% of fibre= loss in weight on incineration *100/weight of sample before defating

3.3.4. Protein percentage estimation

3.3.4.1. Apparatus

Kjeldal flask, Kjeldal distillation unit,

Titration unit

Chemicals

Conc. Sulphuric acid, catalyst

3.3.4.2. Method

- 0.4-0.6 g of freshly ground sample was added to a Kjeldal tube.
- 10 ml of conc. Sulphuric acid and catalyst was added into the flask.
- the tube was gently washed to reduce the particles remaining on the wall

Sample digestion

- The digestion heating system was turned on and set the temperature.
- The Kjeldal tube was placed on the rack of the digester and the fume removing tube was fixed to it.
- The sample was allowed to digest about a day.
- Then it was removed from the system and allowed it to cool about 15 minutes.
- Then 75 ml of distilled water was added to the tube carefully.

Distillation

- The alkaline level of the tank was checked in the tank.
- 25ml of 4.0% boric acid was purred in to the receiver flask and few drops of bromocresol green were added to it.
- The digested sample was purred in to the distillation flask.
- The steam was injected in to the system.
- The exerting NH_3 gas was bubbled in to the receiver flask.

Titration

- The content in the receiver flask was titrated against 0.1N HCl.
- The crude protein percentage was calculated by the formula below.

Weight of nitrogen = N (HCl) * (corrected volume of HCl * 14g/mol)

N % = weight of N * 100 / sample weight

Crude protein % = N % * 6.25

3.3.5. The method of steam distillation of essential oil.

Apparatus: steam distillation unit

Method:

- A correctly weighted 50 g sample was obtained and it was put in the distillation flask. and the content was boiled with water
- The distilled content was collected until the essential oil level is a constant.
- The level of essential oil was observed.
- The essential oil content was separated from the water below And taken in to a pre weighted flask.
- The flask was correctly weighted by a electronic balance.

CHAPTER 04

RESULTS AND DISCUSSION

4.1. Determination of best formula

4.1.1. Sensory evaluation for finding the best coriander proportion.

In this test there were four samples formulated by using three proportions of coriander. Those were: Sample number –359 = 40% of coriander

Sample number -514 =60% of coriander

Sample number- 188 = 80% of coriander

Then they were tested by sensory evaluation and the 9 scale hedonic sensory evaluation ballot paper was used.(Shown in appendix i)

Then the data were analysed by the Minitab statistical package from the Krushkal – Wallis non – parametric test.

The test results for taste verses coriander proportion.

Here there two hypothesis can be drown. H0: the tastes of the three samples are significant Vs H1: At least one sample differs from others.

In this test there the p- value is 0.000 and that is less than 0.05 significant level so the H0 can be rejected. then the highest average rank was observed from the chart and that sample was selected as the best sample for the taste. Median value that resembles the sample was taken as the value of the hedonic table. In this teat the sample number 512 was taken the highest values at the hedonic table. It was 8.000 and it resembles the "Like very much" statement in the hedonic table.(krushkal – wallis test paper – appendix vii)

The test results for colour verses coriander proportion.

Here the hypothesis was H0: The median of the colour of three samples are significant Vs H1: At least one sample median is differs from others.

Here the H0 was rejected because the p- value = 0.000 and is less than 0.05 significant level. The maximum average sum of rank was 31.7 and it resembles the sample 514 and the median is 8.000. And it was resembled the "like very much" statement in the sensory evaluation ballot paper for colour.

The test results for smell verses coriander proportion.

Here the test was H0: The smells of the three samples were not significant. Vs H1: At least one sample medium is significant from others.

Here the p- value = 0.000 and is lower than 0.05 significant level. So the null hypothesis is rejected. The ample number 514 got the highest average rank sums (32.5) and got the median of 8.000 that resembles the "like very much" statement in the hedonic table.

The test results for appearance verses coriander proportion.

Here the test was H0: The median values of relating the appearance of three samples are not significant. Vs H1: At least one sample median is significant from others. In the Krushkal – Wallis test the P- value was 0.000 and the null hypothesis was rejected. The sample number 514 got the highest sum of ranks (30.6), and got the median value of 8.000 in the test, that resemble the "like very much" statement.

The test results for overall acceptance verses coriander proportion.

Here the test was H0: The median values relating the overall acceptance of three samples are not significant. Vs H1: At least one sample median is significant from others. In the Krushkal – Wallis test the P- value was 0.000 and the null hypothesis was rejected. The sample number 514 got the highest sum of ranks (31.9) and got the median value of 8.000 that resembles the "like very much" statement. (The statistics are shown in the appendices vii)

Form the Krushkal- Wallis test the sample number 514 got the best place in taste, colour, smell, appearance and the overall acceptance.

4.1.2. Sensory evaluation for finding the best Fennel and Cumin proportion.

In this sensory evaluation test three samples of curry powder were tested according to the proportions of Cumin and Fennel verses the sample number.

Sample number 238 – Cumin 15.4% and Fennel 15.4%

Sample number 425 – Cumin 20.0% and Fennel 10.8%

Sample number 567 – Cumin 10.8% and Fennel 20.0%

Three samples were tested by conducting a sensory evaluation test with a 9- point hedonic table (appendix ii). The data were analysed with the Minitab statistical program.

The test results for taste verses Cumin and Fennel proportion.

Here the test is H0: The medians of three samples relating the taste are not significant Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value for the test was 0.009 and it is less than 0.05 significant level. So that the H0 is rejected. The sample number 452 got the highest average rank sum (32.3) and

got the median value of 8.000 that resembles the " like very much" statement in the hedonic table.

The test results for colour verses Cumin and Fennel proportion.

Here the test was H0: The median values of the colour of the samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.000 and it was less than 0.05 significant level. So the null hypothesis was rejected. The sample number 452got the highest average sum of ranks 32.8, and it got the median value of 8.000 that resemble the " like very much" statement of the hedonic table.

(Statistics are shown in appendix vii)

The test results for smell verses Cumin and Fennel proportion.

Here the test was H0: Medians got by the smell of three samples are not significant. Vs H1: At least one sample median differs from others. Here in the Krushkal – Wallis test the p- value was 0.400 and it was higher than the 0.05 significant level. So the null hypothesis was accepted. So there is no significance between the smells of these three samples. (Statistics are shown in appendix vii)

The test results for Appearance verses Cumin and Fennel proportion.

Here the test was H0: The medians got by the appearance of the three samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.000 and was less than 0.05 significant level. So the H0 was rejected. The sample 452 got the highest sum of ranks 34.6 and got the median value of 8.000 that resembles the "like very much" statement of the hedonic table.

(Statistics are shown in appendix vii)

The test results for Overall acceptance verses Cumin and Fennel proportion.

Here the test is H0: The medians got by the overall acceptance of three samples were not significant. Vs H1: At least one sample median differs from others. In the krushkal – Wallis test the P – value was 0.001 and it was less than 0.05 significant level. So the null hypothesis (H0) is rejected. The sample 452 got the highest sum of ranks and got the median value of 8.000 that resembles the statement "like very much" in the hedonic table. (Statistics are shown in appendix vii)

So by the second sensory evaluation test the sample number 452 got the highest values in taste, colour, smell, appearance and overall acceptance.

4.1.3. Sensory evaluation for finding the best Fenugreek and Ginger proportion.

In this sensory evaluation three samples of curry mixes were tested according to the different proportions of Fenugreek and Ginger

Sample number 760 = Fenugreek 6% and Ginger 0.9%

Sample number 245 = Fenugreek 2% and Ginger 0.3%

Sample number 456 = Fenugreek 4% and Ginger 0.6%

A sensory evaluation was conducted to find the best sample on taste, colour, smell, appearance and overall acceptance categories. A 9- scale hedonic table was used to record the data (appendix iii). The results were analysed from the Minitab Statistical Package by the Krushkal – Wallis non parametric test.

The test results for taste verses Fenugreek and Ginger proportion.

The test was H0: Medians relating the taste of the samples are not significant. Vs H1: At least one sample median differs from others. By the Krushkal – Wallis test the P-value was 0.028 and is less than 0.05 significant level. So the H0: is rejected and the sample 760 got the highest sum of ranks and got the median value of 8.000 that resembles the "like very much" statement in the hedonic table. (Statistics are shown in appendix viii)

The test results for colour verses Fenugreek and Ginger proportion.

Here the test was H0: The median values of the colour of the samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.001 and it was less than 0.05 significant level. So the null hypothesis was rejected. The sample number 760 got the highest average sum of ranks, and it got the median value of 8.000 that resemble the "like very much" statement of the hedonic table.

(Statistics are shown in appendix viii)

The test results for smell verses Fenugreek and Ginger proportion.

Here the test was H0: Medians got by the smell of three samples are not significant. Vs H1: At least one sample median differs from others. Here in the Krushkal – Wallis test the p- value was 0.753 and it was higher than the 0.05 significant level. So the null hypothesis was accepted. So there is no significance between the smells of these three samples. (Statistics are shown in appendix viii)

The test results for appearance verses Fenugreek and Ginger proportion.

Here the test was H0: The medians got by the appearance of the three samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.014 and was less than 0.05 significant level. So the H0 was rejected. The sample 245 got the highest sum of ranks 31.8 and got the median value of 7.500 that resembles the "like very much" statement of the hedonic table. (Statistics are shown in appendix viii)

The test results for Overall acceptance verses Fenugreek and Ginger proportion.

Here the test is H0: The medians got by the overall acceptance of three samples were not significant. Vs H1: At least one sample median differs from others. In the krushkal – Wallis test the P – value was 0.005 and it was less than 0.05 significant level. So the null hypothesis (H0) is rejected. The sample 760 got the highest sum of ranks (32.4) and got the median value of 8.000 that resembles the statement "like very much" in the hedonic table. (Statistics are shown in appendix viii)

The test results were shown that the sample 760 is the best from taste, colour and overall acceptance, but the sample 245 got the best for the appearance. For the smell the test given that is was not significant between the three samples.

4.1.4. Sensory evaluation for finding the best turmeric proportion.

In this sensory evaluation test three samples of curry powder were tested according to the proportions of Cumin and Fennel verses the sample number.

Sample number 122 – Turmeric 3%

Sample number 367 – Turmeric 5%

Sample number 587 – turmeric 7%

Three samples were tested by conducting a sensory evaluation test with a 9- point hedonic table (appendix iv). The data were analysed with the Minitab statistical program.

The test results for taste verses Turmeric proportion.

Here the test is H0: The medians of three samples relating the taste are not significant Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value for the test was 0.036 and it is less than 0.05 significant level. So that the H0 is rejected. The sample number 367 got the highest average rank sum (30.5) and got the median value of 8.000 that resembles the "like very much" statement in the hedonic table. (Statistics are shown in appendix ix)

The test results for colour verses Turmeric proportion.

Here the test was H0: The median values of the colour of the samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.000 and it was less than 0.05 significant level. So the null hypothesis was rejected. The sample number 367 got the highest average sum of ranks 35.3, and it got the median value of 9.000 that resemble the "like extremely" statement of the hedonic table. (Statistics are shown in appendix ix)

The test results for smell verses Turmeric proportion.

Here the test was H0: The medians got by the smell of three samples are not significant. Vs H1: At least one sample median differs from others. Here in the Krushkal – Wallis test the p- value was 0.036 and it was less than the 0.05 significant level. So the null hypothesis was rejected. And the sample number 367 got the highest sum of average ranks, 31.0 and it got the median value of 8.000 that resembles the "like very much" Statement in the hedonic table. (Statistics are shown in appendix ix)

The test results for appearance verses Turmeric proportion.

Here the test was H0: The medians got by the appearance of the three samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.000 and was less than 0.05 significant level. So the H0 was rejected. The sample 367 got the highest sum of ranks 35.2 and got the median value of 9.000 that resembles the "like extremely" statement of the hedonic table. (Statistics are shown in appendix ix)

The test results for overall acceptance verses Turmeric proportion.

Here the test is H0: The medians got by the overall acceptance of three samples were not significant. Vs H1: At least one sample median differs from others. In the krushkal – Wallis test the P – value was 0.000 and it was less than 0.05 significant level. So the null hypothesis is rejected. The sample 367 got the highest sum of ranks (35.9) and got the median value of 9.000 that resembles the statement "Like extremely" in the hedonic table. (Statistics are shown in appendix ix)

From the sensory evaluation the sample 367 was the best from taste, colour, smell, appearance and overall acceptance.

4.1.5. Sensory evaluation for finding the best chilli proportion.

In this sensory evaluation test three samples of curry powder were tested according to the proportions of chilli verses the sample number.

Sample number 768 – Chilli 5%

Sample number 521 – Chilli 8%

Sample number 895 – Chilli 11%

Three samples were tested by conducting a sensory evaluation test with a 9- point hedonic table (appendix v). The data were analysed with the Minitab statistical program.

The test results for taste verses Chilli proportion.

Here the test is H0: The medians of three samples relating the taste are not significant Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value for the test was 0.001 and it is less than 0.05 significant level. So that the H0 is rejected. The sample number 521 got the highest average rank sum (34.6) and got the median value of 9.000 that resembles the " like extremely" statement in the hedonic table. (Statistics are shown in appendix x)

The test results for colour verses Chilli proportion.

Here the test was H0: The median values of the colour of the samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.000 and it was less than 0.05 significant level. So the null hypothesis was rejected. The sample number 521 got the highest average sum of ranks (36.2), and it got the median value of 9.000 that resemble the "like extremely" statement of the hedonic table. (Statistics are shown in appendix x)

The test results for smell verses Chilli proportion.

Here the test was H0: The medians got by the smell of three samples are not significant. Vs H1: At least one sample median differs from others. Here in the Krushkal – Wallis test the p- value was 0.003 and it was less than the 0.05 significant level. So the null hypothesis was rejected. And the sample number 512 got the highest sum of average ranks, 33.5 and it got the median value of 8.000 that resembles the "like very much" Statement in the hedonic table. (Statistics are shown in appendix x)

The test results for appearance verses Chilli proportion.

Here the test was H0: The medians got by the appearance of the three samples are not significant. Vs H1: At least one sample median differs from others. In the Krushkal – Wallis test the P- value was 0.000 and was less than 0.05 significant level. So the H0 was rejected. The sample 512 got the highest sum of ranks 35.6 and got the median value of 9.000 that resembles the "like extremely" statement of the hedonic table. (Statistics are shown in appendix x)

The test results for overall acceptance verses Chilli proportion.

Here the test is H0: The medians got by the overall acceptance of three samples were not significant. Vs H1: At least one sample median differs from others. In the krushkal – Wallis test the P – value was 0.000 and it was less than 0.05 significant level. So the null hypothesis is rejected. The sample 512 got the highest sum of ranks (37.6) and got the median value of 9.000 that resembles the statement "Like extremely" in the hedonic table. (Statistics are shown in appendix x)

4.2. The results of the microbiological testing

4.2.1. Yeast and mould test

Table – 4.1 Yeast and Mould count

dilution	Number of colonies in Plate 2	Number of colonies in Plate 2
10^{-1} dilution	10	8
10^{-2} dilution	3	2
10^{-3} dilution	1	0

The blank plate – 0 colonies.

Calculation

$$N = \frac{\sum C}{(N * 0.1 + N * 0.01 + N * 0.001)\, d}$$

N= 24/ 0.222

N= 108.1081

4.2.2. Total plate count.

Table – 4.2 Total plate count

dilution	Number of colonies in Plate 2	Number of colonies in Plate 2
10^{-1} dilution	22	18
10^{-2} dilution	7	5
10^{-3} dilution	1	2

The blank plate = 0

$$N = \frac{\sum C}{(N * 0.1 + N * 0.01 + N * 0.001)\, d}$$

$N = 55 / 0.222$

$N = 247.747$

4.3. The results of the proximate analysis

Table – 4.3 Proximate analysis results

Component	g per 100 g of curry powder
Moisture	8.5 g
fat	10.8 g
Protein (N x 6.25)	9.5 g
Fibre	23.01 g
Volatile oil content	4.3 g
Ash	2.34 g

4.4. The effect of the mill type on grinding

Table – 4.3Effect of mills

Mill type	Volatile oil remaining in Sample1 from50 g	Volatile oil remaining in Sample2 from 50g	Volatile oil remaining in Sample3 from 50g
Plate mill	1.28 g	1.24 g	1.31 g
Masala mill	2.34 g	2.53 g	2.47 g

The average volatile oil content

Plate mill : 1.27 g

Masala mill: 2.476 g

So the average of the volatile oil remaining in the samples after grinding is higher in the Masala mill sample

So the Masala mill is better than the plate mill when grinding spices because it retains more volatile oil when processing.

4.5. The effect of the packing material on volatile oil content.

Table – 4.5 Effect of packaging

Packing material	Volatile oil remaining in Sample1 from50 g	Volatile oil remaining in Sample2 from 50g	Volatile oil remaining in Sample3 from 50g
PET bags	2.41g	2.39g	2.43g
PET bottles	2.50g	2.48g	2.47g
Nylon	2.53g	2.54g	2.50g
Triple laminated	2.34g	2.29g	2.36g
150 LDPE in cans	2.26g	2.18g	2.24g

Average of the oil content that was remaining was

Nylon = 2.523g

PET bottle = 2.483g

PET bags = 2.410g

Triple layer = 2.330g

LDPE150in can = 2.220g

CHPTER 05

CONCLUTIONS

5.1. General conclusions

- the best proportion for a instant spiced curry powder is

Table . 5– 1 Final Formula

The spice	% by weight
coriander	52
cumin	10.8
fennel	20
cinnamon	0.3
clove	0.3
ginger	0.9
fenugreek	6
turmeric	5
cardamom	0.3
chillies	8
curry leaves	1.7

- The best packing material would be for the spice packaging

  Nylon> PET bottles> PET bags > triple laminated bags> LDPE 150 in cans
  So the best packing material for spice powder would be Nylon

- The better grinding mill type for grinding spices is the masala hammer mill.

5.2. Further studies

- should study on the shelf life must be done by keeping the samples in most suitable packing material for longer period of time

CHAPTER 6

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Appendix i

Sensory Evaluation Ballot Paper

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

This is based on developed curry powders.

Instructions:-

- Please taste the samples according to the following order.

Sample Codes:-

- Rank the samples according to data given below

Like extremely.....9

Like very much.....8

Like moderately.....7

Like slightly.....6

.....

Neither like not dislike.....5

Dislike slightly.....4

Dislike moderately.....3

Dislike very much.....2

Dislike extremely.....1

	521	768	895
Colour			
Smell			
Appearance			
Taste			
Overall Acceptance			

Your comments.....
.....
.....

Thank you

Appendix ii

Sensory Evaluation Ballot Paper

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

This is based on developed curry powders.

Instructions:-

- Please taste the samples according to the following order.

Sample Codes:-

- Rank the samples according to data given below

Like extremely.....9

Like very much.....8

Like moderately.....7

Like slightly.....6

.....

Neither like not dislike.....5

Dislike slightly.....4

Dislike moderately.....3

Dislike very much.....2

Dislike extremely.....1

	521	768	895
Colour			
Smell			
Appearance			
Taste			
Overall Acceptance			

Your
comments.....
.....
.....

Thank you

Sensory Evaluation Ballot Paper

Appendix iii

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

This is based on developed curry powders.

Instructions:-

- Please taste the samples according to the following order.

Sample Codes:-

- Rank the samples according to data given below

Like extremely.....9

Like very much.....8

Like moderately.....7

Like slightly.....6

Neither like not dislike.....5

Dislike slightly.....4

Dislike moderately.....3

Dislike very much.....2

Dislike extremely.....1

	521	768	895
Colour			
Smell			
Appearance			
Taste			
Overall Acceptance			

Your comments.....
.....
.....

Thank you

Appendix iv

Sensory Evaluation Ballot Paper

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

This is based on developed curry powders.

Instructions:-

- Please taste the samples according to the following order.

Sample Codes:-

- Rank the samples according to data given below

Like extremely.....9

Like very much.....8

Like moderately.....7

Like slightly.....6

.....

Neither like not dislike.....5

Dislike slightly.....4

Dislike moderately.....3

Dislike very much.....2

Dislike extremely.....1

	521	768	895
Colour			
Smell			
Appearance			
Taste			
Overall Acceptance			

Your comments.....

.....

.....

Thank you

Appendix v

Sensory Evaluation Ballot Paper

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

This is based on developed curry powders.

Instructions:-

- Please taste the samples according to the following order.

Sample Codes:-

- Rank the samples according to data given below

Like extremely.....9

Like very much.....8

Like moderately.....7

Like slightly.....6

.....

Neither like not dislike.....5

Dislike slightly.....4

Dislike moderately.....3

Dislike very much.....2

Dislike extremely.....1

	521	768	895
Colour			
Smell			
Appearance			
Taste			
Overall Acceptance			

Your comments.....
.....
.....

Thank you

Appendix vi

Kruskal-Wallis Test: Taste versus Sample number

44 cases were used
1 cases contained missing values

Kruskal-Wallis Test on Taste

Sample Number	N	Median	Ave Rank	Z
188	15	6.000	19.9	-0.97
359	14	6.500	13.2	-3.28
514	15	8.000	33.8	4.18
Overall	44	22.5		

H = 19.47 DF = 2 P = 0.000
H = 20.37 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Colour versus Sample number

44 cases were used
1 cases contained missing values

Kruskal-Wallis Test on Colour

Sample Number	N	Median	Ave Rank	Z
188	15	8.000	24.8	0.87
359	14	6.000	10.1	-4.37
514	15	8.000	31.7	3.43
Overall	44	22.5		

H = 21.28 DF = 2 P = 0.000
H = 22.52 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Smell versus Sample number

44 cases were used
1 cases contained missing values

Kruskal-Wallis Test on Smell

Sample number	N	Median	Ave Rank	Z
188	15	7.000	20.5	-0.74
359	14	6.000	13.9	-3.02
514	15	8.000	32.5	3.71

Overall	44		22.5	

H = 15.69 DF = 2 P = 0.000
H = 16.59 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Appearance versus Sample number

44 cases were used
1 cases contained missing values

Kruskal-Wallis Test on Appearance

Sample number	N	Median	Ave Rank	Z
188	15	8.000	25.4	1.09
359	14	5.500	10.7	-4.16
514	15	8.000	30.6	3.00
Overall	44		22.5	

H = 18.48 DF = 2 P = 0.000
H = 19.44 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Overall acceptance versus Sample number

43 cases were used
2 cases contained missing values

Kruskal-Wallis Test on Overall acceptance

Sample number	N	Median	Ave Rank	Z
188	15	7.000	20.2	-0.69
359	13	5.000	12.6	-3.23
514	15	8.000	31.9	3.80
Overall	43		22.0	

H = 16.96 DF = 2 P = 0.000
H = 17.64 DF = 2 P = 0.000 (adjusted for ties)

Appendix vii

Kruskal-Wallis Test: Taste versus sample number

Kruskal-Wallis Test on Taste

sample number	N	Median	Ave Rank	Z
238	16	6.500	17.6	-2.43
452	16	8.000	32.3	2.74
567	16	7.000	23.6	-0.32
Overall	48		24.5	

H = 9.02 DF = 2 P = 0.011
H = 9.51 DF = 2 P = 0.009 (adjusted for ties)

Kruskal-Wallis Test: Colour versus sample number

Kruskal-Wallis Test on Colour

Sample Number	N	Median	Ave Rank	Z
238	16	6.000	13.8	-3.74
452	16	8.000	32.8	2.91
567	16	7.000	26.9	0.83
Overall	48		24.5	

H = 15.43 DF = 2 P = 0.000
H = 16.64 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Smell versus sample number

Kruskal-Wallis Test on Smell

sample number	N	Median	Ave Rank	Z
238	16	7.000	21.9	-0.92
452	16	7.000	28.1	1.26
567	16	7.000	23.5	-0.34
Overall	48		24.5	

H = 1.69 DF = 2 P = 0.429
H = 1.83 DF = 2 P = 0.400 (adjusted for ties)

Kruskal-Wallis Test: Appearance versus sample number

Kruskal-Wallis Test on Appearance

sample number	N	Median	Ave Rank	Z
238	16	6.000	12.9	-4.06
452	16	8.000	34.6	3.53
567	16	7.000	26.0	0.52
Overall	48		24.5	

H = 19.47 DF = 2 P = 0.000
H = 21.06 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Overall acceptance versus sample number

Kruskal-Wallis Test on Overall acceptance

sample number	N	Median	Ave Rank	Z
238	16	6.000	15.9	-3.02
452	16	8.000	34.1	3.36
567	16	7.000	23.5	-0.34
Overall	48		24.5	

H = 13.66 DF = 2 P = 0.001
H = 14.58 DF = 2 P = 0.001 (adjusted for ties)

Appendix viii

Kruskal-Wallis Test: Taste versus sample number

Kruskal-Wallis Test on Taste

sample number	N	Median	Ave Rank	Z
245	16	7.000	24.1	-0.13
456	16	7.000	18.3	-2.18
760	16	8.000	31.1	2.31
Overall	48		24.5	

H = 6.72 DF = 2 P = 0.035
H = 7.12 DF = 2 P = 0.028 (adjusted for ties)

Kruskal-Wallis Test: Colour versus sample number

Kruskal-Wallis Test on Colour

Sample number	N	Median	Ave Rank	Z
245	16	7.000	27.3	1.00
456	16	6.500	14.3	-3.55
760	16	8.000	31.8	2.56
Overall	48		24.5	

H = 13.45 DF = 2 P = 0.001
H = 14.56 DF = 2 P = 0.001 (adjusted for ties)

Kruskal-Wallis Test: Smell versus sample number

Kruskal-Wallis Test on Smell

sample number	N	Median	Ave Rank	Z
245	16	7.000	23.7	-0.30
456	16	7.000	23.3	-0.43
760	16	7.000	26.6	0.72
Overall	48		24.5	

H = 0.53 DF = 2 P = 0.769
H = 0.57 DF = 2 P = 0.753 (adjusted for ties)

Kruskal-Wallis Test: Appearance versus sample number

Kruskal-Wallis Test on Appearance

sample number	N	Median	Ave Rank	Z
245	16	7.500	31.8	2.57
456	16	6.000	17.8	-2.35
760	16	6.500	23.9	-0.22
Overall	48		24.5	

H = 8.12 DF = 2 P = 0.017
H = 8.58 DF = 2 P = 0.014 (adjusted for ties)

Kruskal-Wallis Test: Overall acceptance versus sample number

Kruskal-Wallis Test on Overall acceptance

Sample number	N	Median	Ave Rank	Z
245	16	7.000	24.2	-0.11
456	16	6.000	16.9	-2.67
760	16	8.000	32.4	2.78
Overall	48		24.5	

H = 9.90 DF = 2 P = 0.007
H = 10.53 DF = 2 P = 0.005 (adjusted for ties)

Appendix ix

Kruskal-Wallis Test: colour versus sample number

Kruskal-Wallis Test on colour

sample number	N	Median	Ave Rank	Z
122	16	7.500	23.3	-0.44
367	16	9.000	35.3	3.78
587	16	7.000	14.9	-3.35
Overall	48		24.5	

H = 17.14 DF = 2 P = 0.000
H = 18.18 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: smell versus sample number

Kruskal-Wallis Test on smell

sample number	N	Median	Ave Rank	Z
122	16	7.500	23.5	-0.34
367	16	8.000	31.0	2.27
587	16	7.000	19.0	-1.94
Overall	48		24.5	

H = 6.02 DF = 2 P = 0.049
H = 6.62 DF = 2 P = 0.036 (adjusted for ties)

Kruskal-Wallis Test: appearance versus sample number

Kruskal-Wallis Test on appearance

Sample number	N	Median	Ave Rank	Z
122	16	8.000	24.4	-0.04
367	16	9.000	35.2	3.75
587	16	6.500	13.9	-3.71
Overall	48		24.5	

H = 18.54 DF = 2 P = 0.000
H = 19.68 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: taste versus sample number

Kruskal-Wallis Test on taste

sample number	N	Median	Ave Rank	Z
122	16	8.000	24.8	0.11
367	16	8.000	30.5	2.09
587	16	7.000	18.2	-2.20
Overall	48		24.5	

H = 6.14 DF = 2 P = 0.046
H = 6.66 DF = 2 P = 0.036 (adjusted for ties)

Kruskal-Wallis Test: overall acceptance versus sample number

Kruskal-Wallis Test on overall acceptance

sample number	N	Median	Ave Rank	Z
122	16	7.500	22.2	-0.81
367	16	9.000	35.9	3.98
587	16	7.000	15.4	-3.17
Overall	48		24.5	

H = 17.70 DF = 2 P = 0.000
H = 19.06 DF = 2 P = 0.000 (adjusted for ties)

Appendix x

Kruskal-Wallis Test: colour versus sample

Kruskal-Wallis Test on colour

sample	N	Median	Ave Rank	Z
521	16	9.000	36.2	4.08
768	16	7.000	18.8	-2.00
895	16	7.000	18.6	-2.08
Overall	48		24.5	

H = 16.64 DF = 2 P = 0.000
H = 17.65 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Smell versus sample

Kruskal-Wallis Test on Smell

sample	N	Median	Ave Rank	Z
521	16	8.000	33.5	3.15
768	16	7.000	18.2	-2.22
895	16	7.500	21.8	-0.93
Overall	48		24.5	

H = 10.47 DF = 2 P = 0.005
H = 11.52 DF = 2 P = 0.003 (adjusted for ties)

Kruskal-Wallis Test: Appearance versus sample

Kruskal-Wallis Test on Appearance

sample	N	Median	Ave Rank	Z
521	16	9.000	35.6	3.75
768	16	7.000	16.9	-2.66
895	16	7.500	21.4	-1.09
Overall	48		24.5	

H = 14.88 DF = 2 P = 0.001
H = 15.79 DF = 2 P = 0.000 (adjusted for ties)

Kruskal-Wallis Test: Taste versus sample

Kruskal-Wallis Test on Taste

sample	N	Median	Ave Rank	Z
521	16	9.000	34.6	3.52
768	16	7.000	16.8	-2.69

895	16	7.500	22.1	-0.83
Overall	48		24.5	

H = 13.55 DF = 2 P = 0.001
H = 14.70 DF = 2 P = 0.001 (adjusted for ties)

Kruskal-Wallis Test: Overall acceptance versus sample

Kruskal-Wallis Test on Overall acceptance

sample	N	Median	Ave Rank	Z
521	16	9.000	37.6	4.59
768	16	7.000	17.8	-2.36
895	16	7.000	18.1	-2.23
Overall	48		24.5	

H = 21.10 DF = 2 P = 0.000
H = 22.71 DF = 2 P = 0.000 (adjusted for ties)

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