DEVELOPMENT OF FUNCTIONAL WHEY BASED TOMATO SOUP INCORPORATING BROCCOLI, ELEPHANT FOOT YAM, PANEER AND SHALLOT

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BY

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MAHATMA GANDHI UNIVERSITY

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ST. TERESA'S COLLEGE, ERNAKULAM

CERTIFICATE

This is to certify that the dissertation work entitled **" DEVELOPMENT OF FUNCTIONAL WHEY BASED TOMATO SOUP INCORPORATING BROCCOLI, ELEPHANT FOOT YAM, PANEER AND SHALLOT "** is a bonafide work done by **Ms. ALEENA SUNIL** (RegNo.VM22FPT001), student of ST. TERESA'SCOLLEGE, ERNAKULAM, MAHATHMA GANDHI UNIVERSITY, in partial fulfillment of the degree of MASTER OF VOCATIONAL IN FOOD PROCESSING TECHNOLOGY. This dissertation work is carried out by her under my supervision and guidance

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CERTIFICATE

This is to certify that the dissertation work entitled **" DEVELOPMENT OF FUNCTIONAL WHEY BASED TOMATO SOUP INCORPORATING BROCCOLI, ELEPHANT FOOT YAM, PANEER AND SHALLOT" "** is an authentic project work carried out by **Ms. ALEENA SUNIL (Reg. No. VM22FPT001)** under the supervision and guidance of **Dr. Dinker Singh.** Assistant Professor, Department of Dairy Technology, Verghese Kurien Institute of Dairy and Food Technology, Mannuthy, Thrissur, submitted in partial fulfillment of requirements for the award of the degree of Master of Vocational in Food Processing Technology, St. Teresa's College Ernakulam, Mahatma Gandhi University.

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DECLARATION

I, ALEENA SUNIL , do hereby declare that the dissertation **" DEVELOPMENT OF FUNCTIONAL WHEY BASED TOMATO SOUP INCORPORATING BROCCOLI, ELEPHANT FOOT YAM, PANEER AND SHALLOT”** is a bonafide record of the project work done by myself in partial fulfillment for the degree of Master of Vocational in Food Processing Technology, St. Teresa's College Ernakulam, Mahatma Gandhi University.

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ALEENA SUNIL

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ABSTRACT

The study was conducted to utilize whey which was considered as major dairy waste. Soup is a flavourful and nutritious liquid food commonly served as the initial part of a meal or snack. In this study aim to Development of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot. The addition of broccoli, yam, paneer helps in improving the health benefits and overall quality of the product. Response Surface Methodology (RSM) was used to optimize the different levels of ingredients such as broccoli, paneer and yam. The product was optimized on the basis of sensory analysis of colour, body, taste, odour, consistency and overall acceptability. An optimized product having 6.96 per cent broccoli , 6 per cent paneer and 7 per cent yam was found to be sensorily acceptable through Response Surface Analysis. Physicochemical analysis of optimized product was done the values were 91.45 per cent for Moisture, 8.5 per cent for Total Solids, 1.59 per cent for Ash, 0.16 per cent for Fat ,0.31 per cent for Protein , 0.73 per cent for crude fibre, 5.76 per cent for carbohydrate 10 for total soluble solids ,4.9 for pH , 150Cp for viscocity , 0.081 % titratable acidity and % scavenging activity of 58.55mg/ml respectively.

Keywords : Whey, soup, broccoli, tomato, elephant foot yam, shallot ,paneer.

1. INTRODUCTION

In recent years, the processing of innovative and nutritious food products has become a significant area of focus. The primary drivers influencing advancements in the food industry include evolving consumer demands, competition among producers, and technological enhancements (Mol,S,2005).

A soup is a nutritious liquid food that is commonly served as the first course of a meal or as preload. Each variety of soup should have its own distinct character.(Fernández-López et al., 2020)

The utilization of whey has been of high significance for dairy industries involved in the production of cheese, paneer, chhana, casein and shrikhand. Whey solids contain half of the valuable milk solids yet are not completely utilized in different food formulations. Consequently, huge amounts of whey are drained and disposed of as waste. Further exploration of opportunities to incorporate whey solids into additional food products could serve to reduce waste and maximize the nutritional value derived from milk(Singh et al ., 2003)

The tomato provides a valuable source of vitamin C and the phytochemical lycopene. A substantial portion of the global tomato harvest is utilized for processing into various goods, including canned tomatoes, tomato powder, tomato juice, ketchup, paste, sun-dried tomatoes or dehydrated pulp, soup, and other items. Tomatoes exhibit potentially beneficial biological activities beyond their conventional role as a source of Vitamin A, with lycopene in particular indicating promising implications for human nutrition and health outcomes (Gawad et al .,2022)

Broccoli (Brassica oleracea var. italica) contains high levels of vitamins, antioxidants, and anti-carcinogenic compounds, giving it a high nutritional value profile. (Yuan et al ., 2009)Broccoli is a low calorie food and an excellent source of dietary fiber. As an anti-cancer vegetable, it contains glucosinolates which are anticancer components(Jaiswal et al ., 2017)

The elephant foot yam (Amorphophallus paeoniifolius), belonging to the family Areceae, is primarily a crop found in Southeast Asia. As a tropical tuber crop, the elephant foot yam possesses high production potential and popularity as a vegetable ingredient incorporated into various delicacies throughout the region's cuisines. (Yadav , & Singh, 2016).

The aim of the study was to Development of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot.The product development of such valuable products was opportunities for the dairy industry to develop functional foods by utilizing whey which was considered as a major dairy waste and by incoprating broccoli, paneer and yam into tomato whey soup were enhance it health.

By considering all the points, this research was framed with the following objectives:

1) To optimize the functional whey-based tomato soup with the best levels of broccoli, elephant foot yam, paneer and shallot based on sensory.
2) To assess the sensory and physio-chemical attributes of developedfunctional vegetable soup.
3) To evaluate cost of the developed functional vegetable soup.

2. REVIEW OF LITERATURE

2.1. FUNCTIONAL FOODS

Functional foods are similar in appearance to conventional foods, with the former being consumed as part of the normal diet. However, functional foods have demonstrated physiological benefits that distinguish them from conventional foods. Specifically, functional foods have been shown to reduce the risk of chronic disease beyond basic nutritional functions. *(Cencic & Chingwaru,2010)*.The Nutrition Business Journal categorized functional food as “food supplemented with additional or concentrated ingredients elevated to functional levels that enhance health or performance” *(Keservan et al.,2010).* Food can be considered functional by utilizing technological or biotechnological processes to increase the concentration of, add, remove, or modify a particular component. Additionally, such processes may be applied to improve the bioavailability of the component, provided that component has been demonstrated to have a functional effect*(Bansode et al.,2021).*

Functional foods provide positive health benefits and are classified as whole foods, fortified foods, enriched foods or enhanced foods/food compounds *(Hasler,2002)* The functional foods market is led by carotenoids, dietary fibers , fatty acids, minerals, and prebiotics/probiotics/ synbiotics. Vitamins and minerals also have a large market presence. Foods containing phytochemicals, enzymes, and antioxidants are steadily growing their market share as well *(Turkme, Akal & Özer,2019).* The development of functional food products presents an increasingly complex challenge as these products must satisfy consumers' expectations by being both appealing and beneficial to health. *(Iriondo-DeHond et al., 2018)*

2.2. MILK AND MILK PRODUCTS

Milk and dairy products have had a long history of inclusion in the human diet, having been consumed for thousands of years and playing an integral role in the nutritional intake and growth of human populations globally. According to current scientific literature, dairy product consumption can positively impact human health by reducing the risk of cardiovascular disease and atherosclerosis. Research also suggests dairy may enhance immune system function overall. *(Anastasova et al.,2018).*Vegetable soup serves as a functional food given its abundance of beneficial components including antioxidants, dietary fibers, vitamins, minerals, essential fatty acids and oligosaccharides. The ingredients found in vegetable soup work to potentially prevent various chronic health issues such as cardiovascular and inflammatory conditions. *(Naghedi-Baghdar 2018).*

India has held the highly sought title of "The largest producer of milk in the world" for several decades. Most farmers keep 1-5 dairy animals for family needs and sell the remaining milklocally. Another opportunity lies in converting small and medium-scale dairy farming operations into commercial ventures at scale, which could generate meaningful employment *(Gayathri et al.,2023)*

Dairy products and milk are essential to human nutrition .They provide high biological value proteins, calcium, essential fatty acids, amino acids, fat, and water solublevitamins.These nutrients support various biochemical and physiological functions within the human body. *(Khan et al.,2019).* Milk products contain many essential nutrients,including oleic acid, conjugated linoleic acid, omega-3 fatty acids, vitamins, minerals, and bioactive compounds such as antioxidants *(Saxelin et al., 2003).* Antioxidants are chemical compounds that can neutralize and remove free radicals, which are continuously produced inside the body *(Yazdanparast and Ardestani,2007)*. The proteins present in milk consist of casein and whey proteins, which are both nutritionally and technologically essential. *(Kubicová, et al., 2019).* They represent an irreplaceable source of amino acid intake for humans. However, milk and dairy products should be consumed according to recommended guidelines, as overconsumption may negatively impact consumer health *(Ware, 2016).*

2.3. WHEY

Whey is the liquid fraction remaining after the production of cheese, chhana, paneer and casein. For many years, it was considered insignificant and was used as animal feed or disposed of as waste Global whey production is estimated at approximately 165 million tons. In India, the primary source of whey is from the production of chhana and paneer. *(Gupta, 2008).* It is no longer viewed as a waste product but rather as a source of nutritionally valuable whey components. As such, its utilization in human food chains is increasingly favoured due to the economic opportunities provided by some of the milk nutrients present in whey *(Macwan et al.,2016).* The Environmental Protection Act (EPA) has established certain limitations regarding the practice of land spreading as a means of whey disposal. This development incentivizes the exploration of additional applications for whey and whey-derived goods *(Tariq et al.,2013)*

The physicochemical properties of whey vary based on its source and differ compared to skim milk, exhibiting less viscosity and lower surface tension. The freezing point of whey is lower than skim milk and its proteins demonstrate instability under heating conditions. Whey proteins are stable, however, against changes in pH *(Kilara, 2015)* . Whey protein contains all 20 amino acids, including all nine essential amino acids. It provides a rich and balanced source of the sulfur amino acids that serve critical roles as antioxidants and as precursors to the potent intracellular antioxidant glutathione *(Shoveller et al.,2005).* Cysteine is important for the biosynthesis of glutathione, a tripeptide with antioxidant, anticarcinogenic, and immune stimulatory properties. The sulfur amino acids also play a key role in regulating whole body protein metabolism, resulting in changes to body composition *(Solak & Akin,2012).*

Whey can be broadly defined as the serum or watery portion of milk remaining after separation of the curd. This occurs when milk proteins are coagulated by acid or proteolytic enzymes*(Macwan et al.,2016*). Whey protein is an excellent ingredient for beverages and a genuine thirst quencher. It provides nutritional value and possesses certain medicinal properties. However, whey has traditionally been treated as a waste by-product of dairy production. Reusing whey protein controls environmental pollution while also adding value to other products. Paneer whey contains approximately 93.6% water, 0.5% fat, 0.4% protein, 5.1% lactose, and 0.4% ash. Whey protein is an excellent ingredient for beverages and a genuine thirst quencher. It provides nutritional value and possesses certain medicinal properties. However, whey has traditionally been treated as a waste by-product of dairy production. Reusing whey protein controls environmental pollution while also adding value to other products. Paneer whey contains approximately 93.6% water, 0.5% fat, 0.4% protein, 5.1% lactose, and 0.4% ash. Whey protein is an excellent ingredient for beverages and a genuine thirst quencher. It provides nutritional value and possesses certain medicinal properties. However, whey has traditionally been treated as a waste by-product of dairy production. Reusing whey protein controls environmental pollution while also adding value to other products. Paneer whey contains approximately 93.6% water, 0.5% fat, 0.4% protein, 5.1% lactose, and 0.4% ash (*Verma et al.,2010).* The consumption of whey can help supplement many of the organic and inorganic nutrients lost from extracellular fluids. Targeting the utilization of these fluids could benefit individuals with strenuous occupations like professional athletes, body builders, recreational athletes, active hobbyists, and others engaged in similar levels of physical activity *(Shanaziya yet al.,2018)*

2.4.PANEER

Paneer, an indigenous dairy product of India, which is used in various culinary dishes and snacks. Paneer has a marble white appearance with a firm, cohesive, and spongy body containing a close-knit texture and slightly sweet, acidic, and nuttyflavor. *(Kumar et al.,2014)* Its characteristics include a mild acidity and slightly sweet taste along with a soft, cohesive, and compact texture. As an excellent substitute for meat in Indiancuisine e, paneer's body and texture must sufficiently hold its shape during cutting and slicing yet remain tender enough not to resist crushing during chewing. Specifically, the texture shouldbe compact and smooth while the color and appearance should be uniform and pleasingly whitewith a greenish tinge for buffalo milk paneer or a light yellow for cow milk paneer *(Srivastavaand Goyal 2007)*

Buffalo milk containing 6% fat was heated to 82°C in a cheese vat for 5 minutes and cooled to 70°C, then coagulated with a 1% citric acid solution added slowly withcontinuous stirring until curd and whey separated. The mixture settled for 10 minutes before draining the whey through a muslin cloth, maintaining the whey temperature above 63°C. Thecurd was then collected and placed in a hoop (35x28x10 cm) lined with a clean, strong muslincloth in a rectangular wooden frame with open top and bottom. The frame was rested on a wooden plank and filled with curd, then covered with another plank and 45 kg weight pressedfor 15-20 minutes. The pressed curd block was removed and cut into 6-8 inch pieces immersedin pasteurized chilled water (4-6°C) for 2-3 hours. The chilled paneer pieces were then placedon a wooden plank for 10-15 minutes to drain excess water before wrapping in parchment paperand refrigerating at 4±1°C. A schematic approach for manufacturing paneer was depicted.

2.4.1. Nutritional Profile of Paneer

Paneer contains approximately 72 calories per 100 grams. It is composed primarily of water (93.5 grams per 100 grams), protein (13 grams), and carbohydrates (3.4 grams). Ash makes up 1.5 grams per 100 grams. The key nutrients found in paneer include protein, fat, fatty acids (omega-3 and omega-6), carbohydrates, and various minerals and vitamins. Paneer provides calcium, phosphorus, magnesium, sodium, potassium, zinc, iron, copper, manganese, selenium, and fluoride. It also contains vitamins A, E, D, C, K, B1, B2, B3, B5, B6, B12, choline, and folates

Moderate consumption of paneer can provide several health benefits. However, overeating paneer is not recommended. Some potential benefits of consuming paneer in moderation include boosting the immune system. It may help prevent tooth decay in children by strengthening enamel. For pregnant women, paneer contains nutrients that can support healthy fetal development. The nutrients in paneer also help build strong bones and provide structure. Paneer has antioxidant properties that may lower the risk of cardiovascular diseases. Research also indicates it could decrease the risk of breast cancer. Additionally, paneer may aid digestion by promoting healthy gut bacteria *(Pal.M.,2019).*

2.5.TOMATO

The tomato (*Solanum lycopersicum*) is an important shrub belonging to the Solanaceae family e (*Aoki et al., 2010*). Commonly known as the love apple, the tomato has different names around the world. In Spanish, it is called jitomate, while in German it is called tomate. In English, it is referred to as either the garden tomato or simply tomato. Tomatoes can be grown under a variety of environmental conditions including temperatures and climates, but the optimal conditions for tomato plant growth are found in warm-climate countries. Germination of seeds is very slow below the optimal temperature and the growth rate also decreases.(*Rehman.et.al.,2020*)

Scientific classification	
Kingdom.	Plantae
Phylum	Angiosperms
Order	Solanales
Family	Solanaceae
Genus	Solanum
Species	lycopersicum

A healthy diet plays an important role in preventing chronic diseases and maintaining energy balance and body weight *(Stahl and Sies, 2005*).. Tomatoes contain many beneficial carotenoids and are a major dietary source of these nutrients. Approximately 40 carotenoids are present in the human diet, but only 25 make it into human blood due to selective absorption in the digestive tract. Tomatoes, both fresh and processed, contain the majority of carotenoids found in blood. Key carotenoids for human health include lycopene, lutein, zeaxanthin and beta-cryptoxanthin *(Shi and Maguer, 2000)*. Lycopene is a lipophilic carotenoid pigment found in tomatoes and other red fruits and vegetables *(Shi et al., 2002)* . It is considered the most potent natural antioxidant, with antioxidant activity twice that of beta-carotene and ten times greater than alpha-tocopherol. Lycopene produced from natural sources, such as tomato extracts, provides nutritional advantages for human health *(Mendelová et al., 2013).*

Tomatoes contain several additional nutrients and phytonutrients that have been demonstrated to provide positive health impacts. These include vitamin E (0.32 mg/100g) and quercetin (0.80 mg/ g), one of the flavonoids that exhibits very high antioxidant activity relative to alpha-tocopherol. Currently, foods based on tomatoes are best recognized for their abundant source of lycopene, a non-vitamin A-active carotenoid that possesses high oxygen radical scavenging and quenching capability*(Beecher,1998).*

A study was conducted to assess the antifungal activity of tomato leaf extract against three pathogenic fungi: Fusarium oxysporum, Glomerella cingulata, and Botryotinis fuckeliana. The volatile compounds released from tomato leaves were found to completely inhibit the growth of G. cingulata and B. fuckeliana. These findings demonstrate that tomato leaves possess a defensive response against pathogenic fungi. Additionally, the volatile components emitted from tomato leaves exhibit potential as biologically-based control agents. *(Kobayashi et al.,2012)*

Lycopene, chlorogenic acid, and p-coumaric acids, which present in tomatoes helps in reducing cancer risk. Individuals who consume tomatoes daily exhibit a lower risk of oral, colorectal, breast, cervical, stomach, prostate, lung cancers and various other cancer types. The anticarcinogenic properties of tomatoes were studied in mice where carcinoma wasinduced via croton oil (carcinogen). The experimental group treated with Solanum lycopersicum demonstrated prolonged time until papilloma appearance compared to animals administered only the carcinogen. The decreased tumor cells may result from effects during tumorigenesis' promotional stage, which halts the depletion of free radicals. Tomatoes and lycopene prove highly important in preventing prostate and various other cancer types *(Agrawal et al .,2009)*

Tomatoes are known to have antioxidant activities and lipid-lowering effects. Ethanolic extracts of tomatoes have anti-obesity activity. Paste of S. lycopersicum reduced plasma levels of malondialdehyde and increased the activities of catalase, glutathione peroxidase, and superoxide dismutase in hamsters. Tomatine is the major component of green tomatoes. It forms tomatine-cholesterol complexes, which are used to lower serum LDL cholesterol. Daily use of tomatoes decreases the weight of adipose tissues, body mass index, food intake, and body weight as well. Due to the antioxidant properties of tomatoes, ethanolic extracts of S. lycopersicum produced anti-obesity effects *(Gautam,2013)*

2.5.1. Medicinal Uses of Solanum lycopersicum

Tomatoes contain high levels of lycopene, a substance used in some expensive over-the-counter facial cleansers. Tomatoes contain significant amounts of calcium and Vitamin K, both essential nutrients for strengthening and performing minor bone and tissue repairs. The Vitamin A in tomatoes is excellent for improving vision. Eating tomatoes is also one of the best ways to prevent night blindness. Tomatoes are rich in chromium, a mineral that effectively helps diabetics better control blood sugar levels. Due to their Vitamin B and potassium content, tomatoes can reduce cholesterol levels and blood pressure. Therefore, regularly including tomatoes in a balanced diet can effectively prevent heart attacks, strokes, and other heart-related issues *(Kumar et al.,2012).*

2.6.BROCCOLI

Broccoli is a cruciferous vegetable belonging to the *Brassicaceae (Cruciferae)* family. Scientifically known as *Brassica oleracea*, broccoli originated in Italy but can now be successfully grown in India as well. It provides a variety of nutrients, including vitamin A, vitamin C, and riboflavin. Broccoli also contains various medicinal compounds. Notably, broccoli contains calcium levels equivalent to milk and supplies ample phosphorus, calcium, manganese, iron, magnesium, selenium, and phosphorus. In addition, broccoli serves as a rich source of electrolytes. *(Singh, J., & Mishra, S ,2020)*

Common name	Broccoli
Scientific name	Brassica oleracea L. var itálica
Order	Brassicales
Family	Cruciferae, Brassicaceae
Origin	Asia(minir) and Southern Europe

Cultivation	It requires loamy and deep soils. Optimal temperatures of growth are low (18°C).It cultivated inrotation with other vegetables
Plants	The plants of broccoli are vigorous and leafy with deep roots.
Varieties	Precocious or early cultivars whose harvesting time is under 90 days after the sowing. Intermediate cultivars that are harvested between 90 and 110 days after the sowing.
Collection	The harvest begins when the inflorescences have achieved a decent development, diameter greater than 13 cm and before flower buds are open.
Uses	Generally it is consumed fresh in salads, cooked in soups, dressings.

Broccoli contains high levels of many vitamins, antioxidants, and compounds that may help prevent cancer. It has significant nutritional value. Bioactive compounds like polyphenols, flavonoids, carotenoids, sulforaphane, glucosinolates, and more can be found in broccoli. It contains vitamins A, B6, B12, C, D, E, K, thiamine, riboflavin, niacin, folate, as well as small amounts of pantothenic acid, choline, and betaine. It also contains calcium, potassium, sodium, phosphorus, and small amounts of zinc, selenium, iron, magnesium, and manganese. The one of the most nutritious vegetable is broccoli. It contain flavanols. Flavanol's come from a large group of flavonoids, which have various chemical structures and properties. Flavonol bioavailability and nutritional intake are primarily impacted by plant species, growth stage, light, ripeness, food preparation procedures, and food processing technologies.Previous research has reported that broccoli flavonoids may have anti-inflammatory and anticancer effects. *(Jaiswal, A. K.2020).*

Glucosinolate, a sulfur-containing compound, is present in various concentrations among plant organs and throughout developmental stages of the plant. It is responsible for distinctive tastes and aromas. When broccoli is consumed, glucosinolates break down into biologically active compounds such as sulforaphane which have been associated with potential anticancer properties. Isothiocyanates, which have the chemical formula

R-N=C=S, are reactive and unstable chemicals that exhibit strong anticarcinogenic activity*(Kour, K,2023)*

Boiling or blanching broccoli at temperatures below 212°F inactivates ESP but not myrosinase. This means the breakdown of glucoraphanin to sulforaphane would be favored over the formation of nitriles. Chopping or cutting broccoli further maximizes this effect. On the other hand, steaming or boiling broccoli can considerably increase its antioxidant capability and recovery of polyphenols. These factors seem promising for using processed broccoli as a functional food with enhanced health-promoting properties *(Mahn & Reyes,2012).*

A study found an association between higher broccoli consumption and a lower likelihood of extensive calcification of the abdominal aorta. Broccoli was also linked to reduced calcium buildup in the heart and several cardio-protective effects, such as inhibition of Phase I enzymes and DNA adducts. Additionally, broccoli was shown to induce Phase II antioxidant and detoxifying enzymes, have antioxidant functions, induce cell cycle arrest, inhibit angiogenesis, and demonstrate anti-inflammatory properties. As a result of these findings, broccoli is considered to have potential as a functional food *(Vasanthi,2012)*

Broccoli contains a significant amount of omega-3 fatty acids, which are well known to be anti-inflammatory. Broccoli can also help those suffering from joint diseases like arthritis as it contains sulforaphane, a chemical that blocks enzymes that can cause joint pain and destruction leading to inflammation. High levels of both calcium and vitamin K are present in broccoli , which were important for bone health and prevention of osteoporosis. It is also full of other nutrients like magnesium, zinc and phosphorus. Broccoli possesses antioxidant propertiesthat help with the overall detoxification of the body. It also contains phytonutrients that aid thebody's detoxification process. In other words, the body is able to rid itself of unwanted contaminants. Broccoli further contains isothiocyanates, which assist the detoxification processat the genetic level. As a powerhouse of antioxidants and nutrients like vitamin C and mineralssuch as copper and zinc, broccoli helps maintain healthy skin. This means it also protects the skin from infection as well as maintaining the neutral glow of one's skin. Broccoli has high amounts of vitamin K, amino acids and folates, making it ideal for maintaining healthy skin immunity. (*Sharma,2022)*

2.7.ELEPHANT FOOT YAM

The elephant foot yam (Amorphophallus paeoniifolius), a member of the family Areceae, is primarily grown in Southeast Asia. This tropical tuber crop has significant production potential and is a popular vegetable ingredient in various regional cuisines. Tuber crops have been identified as the third most important food source globally after cereals and legumes *(Yadav & Singh,2016)*

Fresh tubers have commonly served as a traditional food source in India, Bangladesh, China, and several Southeast Asian nations *(Raviet al.,2007).* Elephant foot yam tubers are considered nutritionally dense as they contain significant levels of carbohydrates (up to 18%) along with proteins (up to 5%), fats (up to 2%), calcium, and vitamins*(Suriya et al., 2019)*

Composition of Amorphophallus Corm			
(per 100 g)			
Moisture	78.7 g	Phosphorus	34 mg
Protein	1.2 g	Iron	0.6 mg
Fat	0.1 g	Vitamin A	434 I.U.
Carbohydrates	18.4 g	Riboflavin	0.07 mg
Minerals	0.8 g	Thiamine	0.06 mg
Calcium	50 mg	Nicotinic acid	0.7 mg

This minor tuber crop is considered to have far better nutritive value than popular tubers like cassava or potato because it contains protein in addition to carbohydrates. The corm, or economic part, can be consumed after boiling and is also suitable for making chips. In addition to being a nutritious food, it possesses medicinal properties. In Ayurveda, it is described as "The King of Tubers." This tuber is widely described as a drug in the context of dietetics and medicine. It cures piles, dyspepsia, and is used in spleenic disorders and gastric problems. The corms can be easily stored without rotting for five to six months under ambient conditions and thus become a good stand-by in households. Considering the least cost, better nutritive value, good medicinal properties and ease of production, popularizing this crop would go a long way in alleviating hunger *(Sini, 2002).*

Konjac foods are a popular health food commonly found in Asian markets and serve as important ingredients in many functional foods. They possess unique physical, chemical, and rheological properties that make them well-suited for various applications. It is known that konjac foods delay stomach emptying due to their low digestibility and high swelling capacity when interacting with gastrointestinal fluids. This more gradual absorption of sugars from meals can help lower spikes in blood sugar levels that typically occur after eating. Research also indicates konjac foods may play a role in regulating blood sugar levels for those with Type 2 diabetes, as well as aiding in body weight control and modulating immune system function within the human body. Due to these benefits, konjac foods are increasingly recognized for their potential health contributions *(Behera& Ray 2017)*

2.8.SPICES

Spices and aromatic herbs have a long history of use as preservatives, colorants, and flavor enhancers dating back to antiquity. Traditionally utilized in medicines across many countries, spices have increasingly the focus of examination within the chemical, pharmaceutical, and food industries due to their possible applications for advancing human health (*Martos et al., 2010)*

2.8.1.SHALLOT

The genus Allium consists of over three hundred different species, though only two, Allium sativum (garlic) and Allium cepa (onion), are well established as preventatives and treatments for various ailments. Shallot is indigenous to Palestine and cultivated in the United States and some European nations. It has historically been utilized in folk medicine to remedy earaches, reduce fevers, and counteract snake venom, as well as purportedly serving as an aphrodisiac *(Amin et al ., 2009)*

Shallots are recognized by several regional names in India including kaanda or gandana in Maharashtra, cheriya ulli in Malyalam, ulli piaja in Odia, and chinna ullipayi in Telgu. Shallots contain fatty acids and minerals that have demonstrated various pharmacological effects impacting the respiratory and nervous systems as well as blood dilution as described in modern medicine. Traditionally, shallots have also been used to show anti-wart, anti-lipoma, anti-kidney stone, and diuretic effects. Shallots contain flavonoids and phenols and have a mild flavor similar to onions *(Abdehvand and Soleymani.,2016).* Allium vegetables have exhibited anti-inflammatory and neurological activity as well as a protective effect against breast cancer. Nutraceuticals derived from Allium vegetables demonstrate potent anti-inflammatory, antioxidant, anti-tumorigenic, anti-invasive, anti-angiogenic, anti-diabetic, neuroprotective, and cardioprotective properties *(Upadhyay,2017).*

MEDICINAL PROPERTIES

- Antibiotic properties
- Anticancer properties
- Hypolipidemi properties
- Antioxidant properties
- Hepatoprotective properties
- Kidney properties
- Hypoglycemic properties

2.8.2.GINGER

Ginger (Zingiber officinale), widely used as a spice in Chinese herbal remedy that has been used to treat various medical conditions affecting the digestive tract. Globally, ginger is a common home remedy for dyspepsia, flatulence, abdominal discomfort, and diarrhea. It has also been utilized to reduce symptoms of nausea and vomiting in pregnancy, motion sickness, or postoperative settings, however the mechanisms responsible for its therapeutic effect have not been well defined(*Wu et al.,2008)*

Ginger contains approximately 50% carbohydrates, 9% protein and free amino acids, 6-8% fatty acids and triglycerides, 3-6% ash, and 3-6% crude fiber on a dry matter basis depending on variety, geography, and climatic conditions. Some African ginger varieties contain 5.98 and 3.72 grams of protein and fat per 100 grams respectively *(Prakash,2010).* Ginger also contains soluble and insoluble fibers. It is a good source of essential micronutrients such as potassium, magnesium, copper, manganese and silicon. Potassium and manganese help build resistance to disease and protect the lining of the heart, blood vessels and urinary passages. Silicon promotes healthy skin, hair, teeth, and nails and helps assimilate calcium. Small amounts of vitamins A, E and some B-vitamins and vitamin C are also found in the ginger rhizome (*Bhatt et al.,2013)*

Ginger is commonly promoted for the treatment of nausea and vomiting. Ginger extract has shown the ability in many cancer cell culture systems to suppress cell proliferation and induce cell death *(Shukla and Singh.,2007*). Ginger and certain constituents have demonstrated antioxidant effects in several cell culture system *(Kim et al.,2007).* Ginger is an herbal medicinal product with a long history of use for treating rheumatic conditions due to its broad anti-inflammatory actions *(Gregory et al .,2008).* Ginger extracts and individual constituents have been reported in in vitro studies to suppress the growth of various common infectious bacteria including Staphylococcus aureus and Listeria monocytogenes (*Singletary,2010)*

2.8.3.GARLIC

Garlic (Allium sativum), a member of the Liliaceae family, is a cultivated food highly regarded around the world. Originally from Central Asia, garlic is one of the earliest cultivated plants. According to a survey conducted by the U.S. Food and Drug Administration of 900 people, garlic stands as the second most utilized supplement (behind Echinacea), with almost 17% of the population using a garlic supplement in the preceding 12 months (*Timbo et al.,2006*). Most garlic consumed today is grown in China, South Korea, India, Spain, and the United States. In addition to its reputation as a healthy food, garlic has demonstrated anti-viral, anti-bacterial, antifungal and antioxidant properties. Additionally, anti-atherosclerotic and anti-cancer properties have also been shown. The majority of sulfur found in whole garlic cloves exists as two equal quantities of S-alkylcysteine sulfoxides and γ-glutamyl-S-alkylcysteines *(Bongiorno et al.,2008)* . Typical garlic food preparation involves chopping, mincing, or crushing the garlic. When subjected to these traumas, the odor-free cysteine sulfoxides are exposed to allinase enzymes, and quickly convert to thiosulfanates, which produce garlic's characteristic aroma *(Pedraza-Chaverrí et al.,2006)*

Garlic has long been utilized for culinary, medical, and spiritual purposes. Research has explored garlic's impact on various health conditions and bodily systems from a medical perspective (*Valente et al., 2014)*.Garlic has also been used to inhibit and treat cardiovascular disease by lowering cholesterol and blood pressure, as an antimicrobial, and a preventive agent for cancer *(Tattelman.,2005).*

Garlic is one of those plants that was used for thousands of years to treat infectious diseases. Historically, garlic has been used to treat severe diarrhea, leprosy, earaches, deafness, constipation, parasitic diseases, and to fight infections, lower fever, and relieve stomach aches. Garlic has several properties for treating skin problems. Garlic contains several powerful antioxidants that help regenerate skin and tissues, making it an extremely effective remedy for acne and pimples treatment *(Rehman & Riaz .,2019)* .

2.9.SOUP

A soup is a flavorful and nutritious liquid food commonly served as the initial part of a meal or snack. Each soup should have its own distinct character. The rising prevalence of obesity in recent years *(Kuczmarski et al., 1994*), especially prominent in affluent societies with unlimited food access, has prompted nutritionists to seek methods for curbing overconsumption.

As humans typically consume their energy through a limited number of large, scheduled meals, one approach may involve inducing feelings of satiation earlier in the meal. A potential strategy is beginning the meal with a soup course (*Jordan et al., 1981; Kissileff, 1985; Rolls et al., 1990a*). The first course of a meal may be viewed as a "preload" that will impact the rate of gastric emptying and consequently the conclusion of the meal. It has been established that nutrient-containing liquids empty from the stomach at a slower rate than water or nonnutrient isotonic liquids, due to feedback from post-gastric receptors *(Horowitz & Dent, 1991; Hunt et al., 1985)*. For meals consisting of both liquid and solid foods, the liquid component of the meal is distributed throughout the stomach.

The taste of the primary ingredient used should remain predominant. Soups can generally be categorized into two types—thick soups and thin (clear) soups. This classification is determined by the texture of the soups (*Fernández et al.,2020)*

Consumption of nutrient-deficient foods can ultimately lead to malnutrition and related diseases. This issue could be addressed by providing easy-to-prepare foods enriched with nutrients. Vegetables are a rich and comparatively inexpensive source of carbohydrates, proteins, vitamins, and minerals. Many specific chemical compounds from vegetables are necessary for the human body's growth, reproduction, and maintenance of health. Foodproducts containing vegetables provide not only nutrients but also change flavor and palatability, acting as an appetizer. The digestible fiber present in vegetables can be helpful intreating constipation. Vegetables are also important in stabilizing hydrochloric acid in the stomach, which helps overall with digestion and provides valuable roughage for moving foodthrough the intestines (*Kour et al .,2023).*

3. MATERIALS AND METHOD

This chapter describes the study materials and methodologies employed during the present the study on the Development of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot. The study was carried out at the Dairy Technology Department, College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University, Mannuthy.

3.1 RAW MATERIALS AND EQUIPMENT

Various ingredients and materials used for the preparation of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot is described below:

3.1.1 Collection of cow milk

Cow milk was obtained from University dairy plant, KVASU , mannuthy .

3.1.2 Paneer and whey

Paneer and whey was prepared using the method standardized by Bhattacharya et al. (1971).

3.1.3 Tomatoes

Good quality tomato were collected from the market. Ripened tomatoes with a uniform outer red coat were selected while the injured and defective fruits were sorted out.

3.1.4 Broccoli

Good quality broccoli were collected from the market. The broccoli florets with a uniform green colour and no visible outer damage were selected for processing.

3.1.5 Elephant Foot Yam

Good quality Elephant Foot Yam were collected from the market.

3.1.6 Shallot , Garlic, and Ginger

Garlic, Ginger and Shallot were obtained from Thrissur local market.

3.1.7 Salt

Commercially available powdered salt obtained from the market was used in the preparation of the product.

3.1.8 Food Grade Citric Acid

The citric acid which is been in powdered form was procured from the local market.

3.1.9 Chemicals

Analytical grade chemicals where used for the work.

3.1.10 Equipments

The equipment available at the Varghese Kurien Institute of Dairy and Food Technology, mannuthy were used for the present study.

3.2 METHODS OF PREPARATION

3.2.2Extraction of whey

The paneer whey was prepared as per the procedure described by prepared using the method by (Kumar et al.,2014). The cow milk was heated in stainless steel bowl to the temperature of 82°C followed by immediate cooling to 70 °C and coagulation, using 1 per cent citric acid solution of 70 °C temperature. After complete coagulation of milk, the coagulum was placed in the muslin cloth so as to drain maximum whey. The whey thus obtained was further heated to 100 °C for 5 minutes so as to remove traces of fat and curd particles. The clear greenish yellowish whey was used for preparation of whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot.

3.2.23 Paneer

Paneer was prepared using the method by *(Kumar et al.,2014)*

Fig.3.1 Flow chart of paneer prepration given below :

Good quality milk

↓

Filtration

↓

Heating (82°C, 5 min)

↓

Cooling (70°C)

↓

Addition of coagulant (1% Citric acid solution at 70°C)

↓

Gentle stirring till clear whey separates out

↓

Settling for 10 min

↓

Draining of whey ⟶ whey

↓

Pressing ⟶ removal of excess whey

↓

Immersion of paneer blocks in chilled water

(4°C for 30 min)

↓

cutting into desired size

↓

Paneer

3.2.24 Preparation of tomato pulp

Fresh red colour tomatoes were washed and blanched until the skins split open, transfer tomatoes into a bowl of ice water to cool. The cooled tomatoes were blended in mixer to make homogenous mass and then this was passed through a metal sieve to remove seed and peel portion. Thus tomato pulp was obtained.

3.2.25 Preparation of Broccoli

Blanching is a cooking process that removes the harsh, bitter taste of raw broccoli while setting its bright green colour. Prior to soup preparation , fresh broccoli were blanched in water at temperatures of 80 C for 1 min, transfer it into a bowl of ice water to cool. Then it is cut into small pieces.

3.2.26 Preparation of Elephant Foot Yam

Blanching is done to prevent browning of Elephant Foot Yam Prior to soup preparation. The Elephant Foot Yam is washed with water thoroughly to remove the dirt and soil. Remove the peel and cut it into cubes were then blanched in boiling water for 10 min transfer it into a bowl of ice water to cool. Then it is grated.

3.2.27 Preparation of spices

Garlic, Ginger and Shallot were washed and peeled. Shallot is chopped into small pieces, ginger and garlic were blended in mixer to make paste form.

3.2.28 Preparation of Soup

The soup was prepared by 1.5 g of Garlic, 1.5 g of Ginger and 3 g of Shallot were sauté inwater then add blanched broccoli , Elephant Foot Yam , paneer , with 25 g of tomato pulp and75ml of whey with 25 ml water. 1g of Salt were added further it was heated for two minutes to obtain of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot (fig.3).

3.2.29 Preparation of control Soup

The control soup was prepared as per the procedure described by Ms. Parjane Minakshi ashokrao (2008). The 1.5 g of Garlic, 1.5 g of Ginger and 3 g of Shallot were sauté in water then with 25 g of tomato pulp and 75ml of whey with 25 ml water. 1g of Salt were added further it was heated for two minutes to obtain of control whey based tomato soup (fig4).

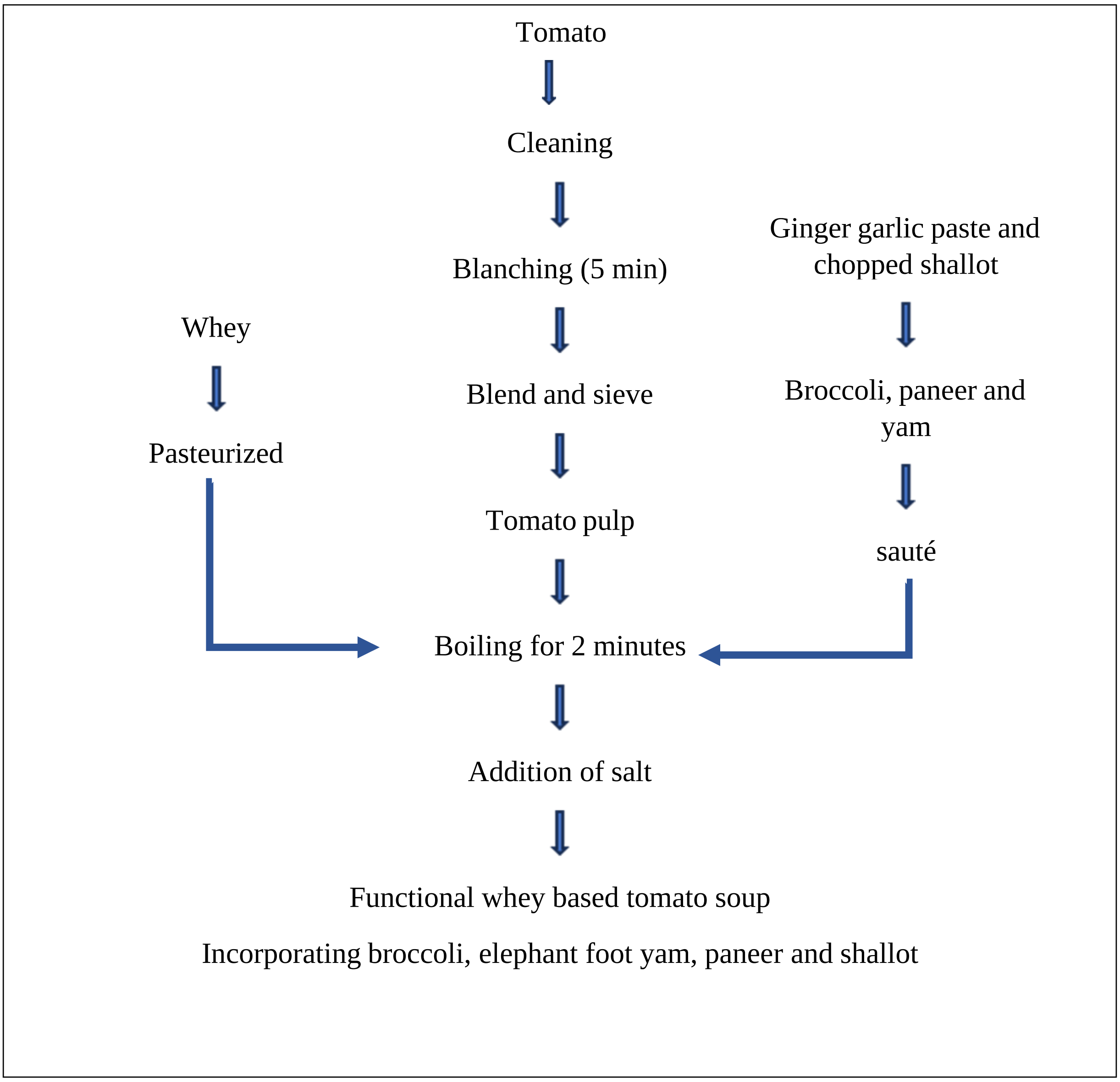


Fig.3.2 Flow chart of soup prepration

Fig:3.3 Sample soup

Fig.34.Control soup

3.3 SENSORY EVALUATION OF SOUP

The sensory evaluation of soup samples were done by panel of 5 judges using 9-point Hedonic Scale. During each replication, samples were judged for various sensory attributes like color, flavour, body and texture, appearance and overall acceptability. The scores were ascertained for each factor and expressed numerically.

SCORE CARD

HEDONIC RATING SCALE

NAME: **DATE:**

NAME OF PRODUCT: Functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot

This is a scale to test how much you like or dislike a particular product. Kindly give us an honest expression of what you feel.

Treatments	Attributes					
	Colour	Body	Taste	Odour	Consistency	Overall Acceptability

Like extremely-9, Like very much-8, Like moderately-7, Like slightly-6, Neither like nor dislike-5, Dislike slightly-4,Dislike moderately-3,Dislike very much- 2,Dislike extremely -1

REMARK SIGNATURE:

3.4 PROXIMATE COMPOSITION AND PHYSICO-CHEMICAL ANALYSIS OF SOUP

PHYSICO-CHEMICAL ANALYSIS

3.4.1 Fat

Fig.3.5.Mojonnier flask.

Fat percentage in prepared soup was estimated according to ISI 1983 by Mojonnier method.

Apparatus

1. Mojonnier flask with lid.
2. Beakers

Procedure

The crude fat content in the functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was determined by method given in AOAC (2012) one gram of the sample was weighed accurately in a clean dry dish.10 ml con HCl was added and heat in a water bath and stir it continuously with a glass rod until the contents turn dark brown and then cool to room temperature. Then add 10mL ethyl alcohol and mix well and transfer the contents into the Mojonnier fat extraction flask.25 mL diethyl ether were added and shaken well and add 25 mL of petroleum ether were thenadded and shaken well. Then allowed the apparatus to stand for a while until the upper layer has become clear and it was distinctly separated from the aqueous layer. Then the solution wasdecanted and repeated the steps for 4 times by using 15 mL diethyl ether and petroleum ether.After that evaporate the solvent and dry in a pre-dried dish in a hot air oven at 100°C for 90 minutes. Then it is Cooled in the desiccator and measured the value using the equation given below.

CALCULATION

$$\text{fat } (\%) = \frac{\text{weight of residue}}{\text{weight of sample}} \times 100$$

3.4.2 Ash

Fig.3.6. Muffle furnace

Principle

Heating the functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot at higher temperature decomposes organic matter and soluble inorganic salts are left behind in the form of ash.

Apparatus

1. Silica crucible.

2. Desiccator.

3. Muffle furnace.

4. Bunsen burner.

Procedure

The total ash content in the functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was determined by method given in AOAC, 2016 (92303). Approximately weigh 3g of sample in a silica crucible**.**The dish was then heated gently in a Bunsen burner until the smoke coming out is getting stopped. Then it was transferred into a muffle furnace and heated at 550°C till the grey ash resulted. The dish was cooled in a desiccator and weighed. eating (for 30 minutes), cooling andweighing were repeated till the difference between two successive weights was less than one milligram. The ash content was determined using formula,

CALCULATION

$$\text{Ash \%} = \frac{\text{weight of ash}}{\text{weight of sample taken}} \times 100$$

3.4.3 Moisture

Fig.3.7. Hot air oven

Apparatus

1. Flat bottom dish.

2. Hot air oven.

Procedure

The moisture content of soup samples were estimated by procedure given by analytical method given in AOAC, 2016. A flat bottom metallic dish was dried at 110 C for 1 hr; cool and°weighted. Then 5 g soup was uniformly spread in dish. It was then dried in a hot air oven at atmospheric pressure. Temperature was maintained at 100 C. After drying°the sample was cooled in desiccator and reweighed. Sample was then reheated, and repeated until the consecutive weighing get. The per cent moisture in sample was calculated using the formula.

CALCULATION

$$\text{Moisture (\%)} = \frac{w1 - w2}{w1}$$

W1 = Weight (g) of sample before drying.

W2 = Weight (g) of sample after drying.

3.4.4 Total Solids

Total solid was determined by methods of AOAC (2016). % total solid content was calculated by using the given following formula:

% Total solids = 100 – % moisture content

3.4.5 Protein

Fig.3.8. Micro Kjeldhal apparatus

The total protein content in soup was determined by Kjeldhal method AOAC 2016.

Apparatus

1. Kjeldhal apparatus.

2. Beakers.

3. Standard flask.

Procedure

Kjeldahl method described by AOAC (2000). Approximately 0.5g of soup sample was taken in a clean dry DTL tube (Kjeldahl flask). Thereafter 10 ml pure nitrogen free sulphuric acid (H_2SO_4), 5g of catalyst mixture (pure potassium sulphate(K_2SO_4)crystals and copper sulphate(Cu_2SO_4)crystals; in the ratio of 5:1) were added into Kjeldahl flask. Thenfor digestion of the content,the Kjeldahl flask was transferred to digestion chamber. Upon digestion, when the content of flask becamescarbon free, the Kjeldahl flask was allowedto cool down. After digestion,the tube was kept for distillation,for which 25 ml of 4% boric acid with indicators(methylene red and bromocresel green) was taken in conical flask. Approximately 90 ml of 40% NaOH solution was used as an alkali source.The conical flask was placed below condenser to collect the condensate. The distillation head was fixed on distillation flask and condenser. The distillation process continued for 10 minutes until about 200 ml distillate was collected in the conical flask. Following the usual precautions the beaker was removed from the assembly. The evolved nitrogen % was determined by titrating condensate with 0.1 N HCl.The per cent total Nitrogen was calculated using the formula:

CALCULATION

$$\text{Percentage of Protein} = \frac{(V1-V2)\times \text{normality of } H2SO4 \times 14 \times 100}{W1 \times 1000}$$

Where,

Where, W1= Weight of sample,

V1 = Volume of 0.1 N H_2SO_4 used in titrating the sample,

V2 = Volume of 0.1 N H_2SO_4 used in blank titration.

The per cent total protein was calculated by multiplying nitrogen with a factor of 6.25

Titrabe acidity

Apparatus

1. Burette

2. Beaker

Reagents

1. Phenolphthalein indicator

2. 0.1 N NaOH

Procedure

Acidity of finished product was determined by titration method as described in ISI (SP18,Part.IS1981). 10 ml of sample well mixed sample into a 100 mL beaker was taken in procelindish, it was mixed with 10ml of distilled water. Then two drops of phenolphthalein indicator was added and titrated against 0.1 NaOH solution with continuous stirring till a faint pink color persisting for 30 seconds

$$Acidity\ as\ percentage\ lactic\ acid = \frac{N \times V \times 0.1}{W}$$

Where,

N= Normality of titrant

V= Volume of titrant

Eq Wt = Equivalent weight of acid

W = Weight of sample

3.4.7 pH Value

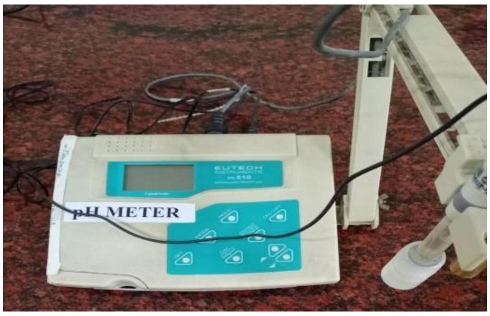


Fig.3.9. pH meter

pH of soup sample was determined by blending 10g of sample with 10 ml of distilled water and dipping the electrode of Eutech PH meter directly into the slurry as per the procedure followed by *O'Keefeeet al.* (1976).

3.4.8 Fiber content

Fig.3.10.Crude fiber apparatus

Apparatus

1. Beaker

2. Silica dish

Procedure

The crude fibre content of ready-to-reconstitute smoothie powder mix was determined by method given in AOAC, 2016(978.10). Weighed accurately about 2 g of sample and transferred it into a hard filter paper supported on a filter cone in a 60 ° funnel. Then it was extracted with three 25 mL portions of ether and applied vacuum until sample was dry. Then transferred the extracted sample quantitatively into a 600 mL beaker of the fibre digestion apparatus. Then add 20 mL of well-mixed ceramic fibre suspension with 200 mL of boiling 1.25% sulfuric acid solution, and 1 drop of diluted antifoam. Then beaker was placed on a digestion apparatus with preadjusted heater and boiled it exactly for 30 minutes and rotated the beaker periodically to keep solids from adhering to sides. Removed beaker and filter contents through California Buchner funnel precoated with about 0.75 g of ceramic fibre - dry weight; then rinsed the beaker with 50-75 mL of boiling water, and wash through funnel. Repeated it with three 50 mLportions of water, and suck dry it. Returned fibre mat with residue to beaker by blowing back through funnel. Then add 200 mL of boiling 1.25% sodium hydroxide solution and returned toheater and boiled exactly for 30 minutes. Then removed beaker and filter as before and wash with 25 mL of boiling 1.25% sulfuric acid solution, three 50 mL portions of water, and 25 mLof alcohol. After that remove mat and residue and transfer it into silica dish. Dried fibre mat and residue at 130 ± 2 °C for 2 hours. Cooled in a desiccator and weighed. Then ignite in mufflefurnace at 550 ± 15 °C to constant weight (30 minutes usually sufficient). Cooled in desiccatorand weighed. The fibre content was determined using the formula,

$$\text{crude fibre} = \frac{\text{w1} - \text{w2}}{\text{ws}} \times 100$$

Where,

Ws = weight of sample

W1= weight of crucible with fibre

W2 = weight of crucible with ash

3.4.9 Total Soluble Solids

Fig.3.11.Refractometer

The measurement of total soluble solids (TSS .^ B) of prepared soup sample were carried out using a digital hand-held refractometer (0 - 37 deg * B)

3.4.10 Total carbohydrate

The total carbohydrate present in soup was determined by method given in AOAC, 2016. In this 100 percent minus total sum of fat, ash, and protein in 100 g of sample.

3.4.11 Antioxidant property

The antioxidant property of the composite flour premix was determined by Brand et al., (1995) method. One gram of sample was dissolved in 10 ml methanol and the solution was kept in a shaker bath for about 2 hours and the solution was centrifuged at 5000 rpm for 20 minutes. The contents were filtered in Whatman no.1 filter paper. 1 ml of sample was incubated with 5 ml DPPH reagent. Incubation was done at 37°C/30 minutes in dark place. Absorbance was noted at 517 nm in a spectrophotometer. The blank was taken with 1 ml water and 5 ml of DPPH solution. DPPH solution was prepared by dissolving 0.0039 g DPPH in 100 ml methanol. The solution was stored overnight in a refrigerator (properly covered with no light entry) for proper mixing of the ingredients. The antioxidant per cent was calculated as below.

$$\%\ \text{Antioxidant activity} = \frac{(\text{Absorbance of Blank} - \text{absorb of sample})}{\text{absorbance of blank}} \times 100$$

3.4.12 Viscosity

Fig.3.12.viscometer

viscosity of soup sample was measured by using (Brookfield viscometer, U.S.A). Spindle number 3 used for measuring viscosity of soup sample. The soup sample was prepared then first, a precise spindle 3 at speed 20 was fixed in order to automatically zero the viscometer. In a 500 ml beaker 300 ml of soup sample was taken and spindle was inserted in beaker. The viscosity was measured for all different samples separately at different speed of spindle

3.4.13 Color characteristics

Fig.3.13.Hunter lab

The colour characteristics of the soup in terms of L*, a* and b* values were determined using Hunter Lab Colorimeter (model D25L.9 Hunter Associates Lab, Inc.). the soup samples were scanned at three different locations and the hunter values were recorded. A low number (0-50) of L * value indicates dark and a high number (51-100) indicates light colour. A negative number of a* indicates green colour positive number of a* value indicates red colour. Similarly, a negative number of b* value indicates blue colour and positive number of b* value indicates yellow.

3.5 EXPERIMENTAL DESIGN

Response surface methodology (RSM) of Design-Expert Software (version 13) was used for the optimization of Soup, The ranges for experimental parameters were selected based on preliminary trials. The process variables considered for optimization were levels of broccoli, yam and paneer. The response to variation in process parameters was measured in terms of colour and appearance, flavour, consistency, and overall acceptability. Experimental design was applied after selection of ranges. Twenty experiments were performed with three independent variables. The data collected from the preliminary analysis were statistically analyzed. The data obtained from sensory analysis were compared using t test.

3.6 COST OF PRODUCTION

The costs incurred when the soup samples were being prepare were calculated on the basis of price of raw materials and processing charges. Other costs like convenience charges and miscellaneous charges were also added.It is the sum total of all the fixed and variable costs.

RESULT

The present study aimed the Development of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot. The physical- chemical properties of soup were determined by performing various analysis. For the preparation of soup, the tomatoes, broccoli, elephant foot yam, shallot, ginger, garlic were collected from local markets. The milk used for soup was collected from the dairy plant of Kerala Veterinary and Animal Science University, Mannuthy.

From the developed soup, various analysis has been performed. The proximate composition and physico-chemical analysis involved the determination of Moisture, Total solids, Crude protein, crude fibre , fat, Ash content, Carbohydrate, viscosity, antioxidant, pH , titrate acidity, color characteristics.

4.1. PRILIMINARY TRIALS

The functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was prepared. The best formulation was selected based on the sensory evaluation of the soup using nine-point hedonic scale. The soup was prepared similar manner with all samples. The data were statistically analyzed for the selection of the minimum and maximum levels of ingredients.

4.2. OPTIMIZATION OF FUNCTIONAL WHEY BASED TOMATO SOUP INCORPORATING BROCCOLI, ELEPHANT FOOT YAM, PANEER AND SHALLOT USING HALF FACTORIAL EXPERIMENT IN DESIGN EXPERT SOFTWARE

The optimization of the soup was done by half factorial experiment indesign expert software. The factors considered were broccoli,elephant foot yam and paneer. The three independent factors were selected and set to their level as minimum and maximum. The experimental design had 20 trials. The design matrix representing different combinations of factors are listed below in table 4.1

Table.4.1. experimental design showing different combinations of the independent

	Factor 1	Factor 2	Factor 3
Run	A:brocoli	B:paneer	C:yam
1	3	6	7
2	8.363586	4.5	5
3	7	3	7
4	7	3	3
5	5	7.022689	5
6	5	4.5	5
7	3	6	3
8	5	4.5	5
9	5	4.5	5
10	7	6	7
11	7	6	3
12	3	3	7
13	5	4.5	5
14	1.636414	4.5	5
15	5	4.5	5
16	5	4.5	1.636414
17	5	4.5	8.363586
18	3	3	3
19	5	1.977311	5
20	5	4.5	5

4.2.1 Effect of different levels of the factors on the sensory attributes of soup

4.2.1.1 Diagnostic check of the quadratic model

The sensory responses viz. colour, body, taste, odour, consistency and overall acceptability of the product influenced by the factors were studied. a quadratic regression model was fitted to the experimental data for each response. The partial regression coefficients of linear, quadratic and interactive terms for regression model for each response with their R^2 and adequate precision values (APV) were formed.

Table.4.2. Sensory score of Soup

Standard run	Colour	Body	Taste	Odour	Consistency	Overall acceptability
1	7.4	7.3	6.8	6.9	7.3	6.75
2	7.3	7.5	6.9	7.25	7.75	7.14
3	6.9	6.25	6.9	6.8	6	6.5
4	7	7.25	7.1	7	7.25	6.6
5	6.8	6.9	7	6.6	6.7	7.5
6	7.1	6.6	7.2	7	6.3	7.6
7	7.35	7.25	7.12	7.39	7.5	7.02
8	7.85	7.3	7.3	7.39	7.3	7.24
9	7	7	6.9	6.5	6.87	6.8
10	7.4	7.1	7.1	7.2	7.1	7.3
11	7	6.9	6.9	6.9	6.7	7.5
12	7.29	7	7.2	7.5	7.2	6.8
13	7.25	7	6.7	7.25	6.8	6.6
14	7.2	7	7.3	7.2	7	7.5
15	7.3	7	7.1	7.4	7	6.95
16	7.2	7.2	7.1	7.6	7.1	7
17	7.1	7	7.1	7.66	6.9	7
18	7.2	6.9	7	7.25	6.9	6.89
19	7.27	7	7.1	7.6	7.12	7.1
20	7.33	7	7	7.66	7.1	6.98

The sensory responses obtained for the individual standard trials suggested by the design expert software are depicted in the table. The evaluation was made by observing the scores on a 9-point hedonic scale.

Table 4.3 Estimated parameters model for each sensory attributes and responses of soup

Table:4.3.1 : Color

Partial coefficient	Coded factors
Intercept	7.21
A – Broccoli	0.1078
B – Paneer	0.0723
C – Yam	0.00305
AB	0.0500
AC	0.1000
BC	0.2625
Model f value	27.54
R^2	0.9271
Adequate precision	24.9374

Table: 4.3.2 : Body

Partial coefficient	Coded factors
Intercept	7.02
A – Broccoli	0.0819
B – Paneer	-0.0060
C – Yam	-0.0183
AB	0.1438
AC	-0.01812
BC	0.02938
Model f value	19.90
R^2	0.9018
Adequate precision	18.8610

Table:4.3.3 : Taste

Partial coefficient	Coded factors
Intercept	7.04
A – Broccoli	0.0744
B – Paneer	0.0750
C – Yam	0.1413
Model f value	49.50
R^2	0.9027
Adequate precision	24.3005

Table:4.3.4: Odour

Partial coefficient	Coded factors
Intercept	7.53
A – Broccoli	0.1558
B – Paneer	0.1347
C – Yam	0.0253
AB	-0.0688
AC	-0.0187
BC	0.1912
A^2	-0.2449
B^2	-0.1211
C^2	-0.1123
Model f value	10.70
R^2	0.9060
Adequate precision	9.6312

Table :4.3.5 : Consistency

Partial coefficient	Coded factors
Intercept	6.99
A – Broccoli	0.1089
B – Paneer	0.0616
C – Yam	-0.0120
AB	0.1250
AC	-0.2875
BC	0.4500
Model f value	21.53
R^2	0.9086
Adequate precision	18.6232

Table :4.3.6 : Overall Acceptability

Partial coefficient	Coded factors
Intercept	7.04
A – Broccoli	0.1209
B – Paneer	-0.1209
C – Yam	0.2056
BC	0.4500
Model f value	96.04
R^2	0.9474
Adequate precision	33.8085

4.2.1.2 Regression equation for predicting the parameters of product optimization

The regression equations for predicting the parameters (factors) for optimizing the product in its maximum sensory perception are given below

Color = 7.21+ 0.1078 *A + 0.0723* B + 0.00305* C + 0.0500* AB + 0.1000* AC+ 0.2625*BC

Body = 7.02 + 0.0819* A - 0.0060* B - 0.0183* C + 0.1438 *AB - 0.01812 * AC + 0.02938* BC

Taste = 7.04 +0.0744*A +0.0750 *B + 0.1413*C

Odor = 7.53+ 0.1558*A + 0.1347*B + 0.0253*C - 0.0688 *AB - 0.0187*AC + 0.1912*BC - 0.2449*A^2 - 0.1211 *B^2 - 0.1123*C^2

Consistency = 6.99 + 0.1089 *A + 0.0616 *B - 0.0120*C+ 0.1250* AB - 0.2875* AC + 0.4500* BC

Overall Acceptability = 7.04 + 0.1209*A - 0.1209*B + 0.2056*C + 0.4500 * BC

4.2.1.3 Effect on Color

The color of soup is given in the table. It ranges from 6.8 and 7.85. The maximum score was observed for standard run 8 which had a high level of broccoli , yam and low level of paneer. The coefficient of determination (R2) was found to be 0.92, with an adequate precision value 24.93. The model F value noted as 27.54 ($p<0.0001$) and with a significant fit. An adequate model was obtained. The 3-D response plots fig. depict the above data.

4.2.1.4 Effect on Body

The body of soup is given in the table. It ranges from 6.25 and 7.5.The maximum score was observed for standard run 2 which had a high level of broccoli and low level ofpaneer ,yam. The coefficient of determination (R2) was found to be 0.90, with an adequate precision value 18.86. The model F value noted as 19.90 ($p<0.0001$) and with a significant fit. An adequate model was obtained. The 3-D response plots fig. depict the above data.

4.2.1.5 Effect on Taste

The taste of soup is given in the table. It ranges from 6.7 and 7.3. The maximum score was observed for standard run 14 which had a high level of yam and low level of paneer, broccoli. The coefficient of determination (R2) was found to be 0.90, with an adequate precision value 24.30. The model F value noted as 49.50 ($p<0.0001$) and with a significant fit. An adequate model was obtained. The 3-D response plots fig. depict the above data

4.2.1.6 Effect on Odour

The body of soup is given in the table. It ranges from 6.25 and 7.5. The maximum score was observed for standard run 20 which had a high level of broccoli,yam and low level ofpaneer , The coefficient of determination (R2) was found to be 0.90, with an adequate precision value 9.63. The model F value noted as 10.70 ($p<0.0001$) and with a significant fit. An adequate model was obtained. The 3-D response plots fig. depict the above data.

4.2.1.7 Effect on Consistency

The body of soup is given in the table. It ranges from 6.25 and 7.5. The maximum score was observed for standard run 2 which had a high level of broccoli and low level of paneer ,yam The coefficient of determination (R2) was found to be 0.90, with an adequate precision value 18.62. The model F value noted as 21.53 ($p<0.0001$) and with a significant fit. An adequate model was obtained. The 3-D response plots fig. depict the above data.

4.2.1.8 Effect on Overall accecptability

The body of soup is given in the table. It ranges from 6.25 and 7.5. The maximum score was observed for standard run 6 which had a high level of broccoli, yam and low level of paneer. The coefficient of determination (R2) was found to be 0.94, with an adequate precision value 33.80. The model F value noted as 96.04 ($p<0.0001$) and with a significant fit. An adequate model was obtained. The 3-D response plots fig. depict the above data.

Fig4.1. Response surface plots for color score of soup added with broccoli, paneer and yam

Fig:4.1 a

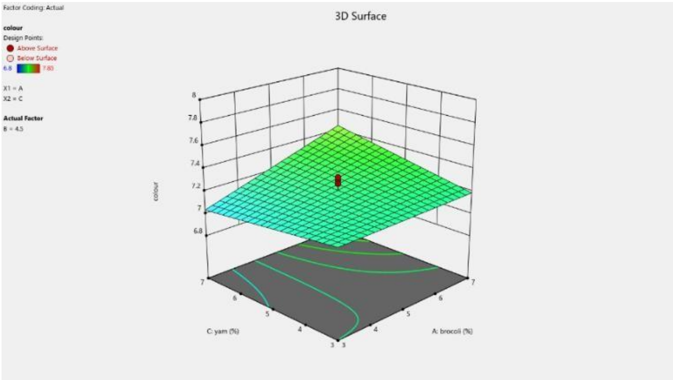


Fig:4.1 b

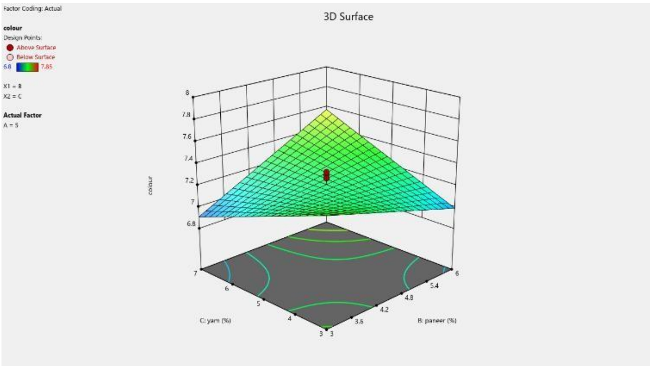


Fig.4.2.Response surface plots for body score of soup added with broccoli, paneer and yam

Fig:4.2 a

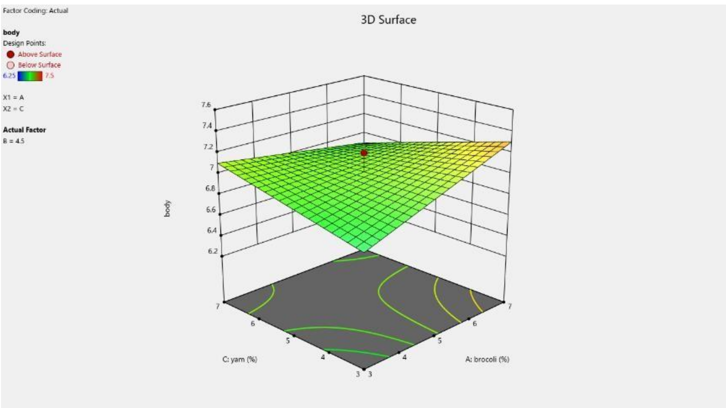


Fig:4.2b

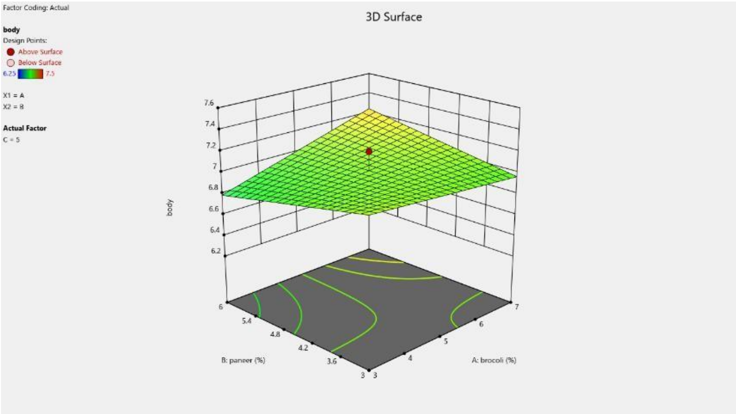


Fig: 4.2 c

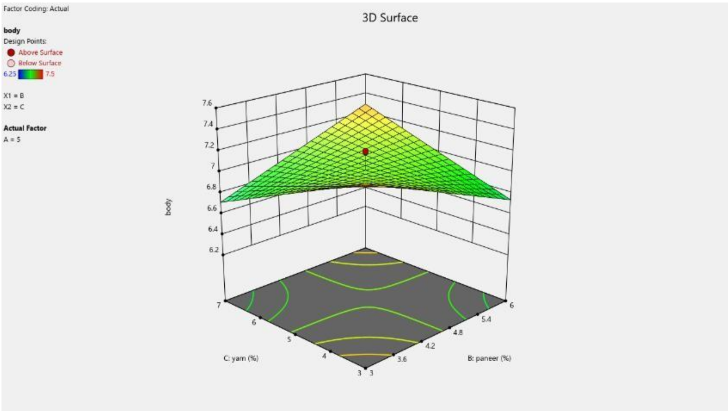


Fig: 4.2 d

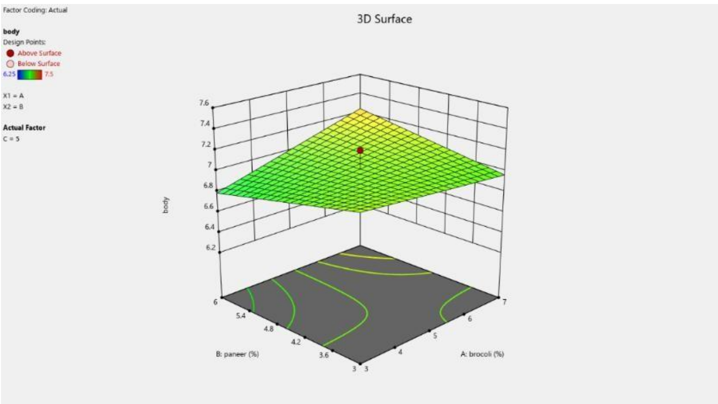


Fig.4.3.Response surface plots for taste score of soup added with broccoli, paneer andyam

Fig:4.3a

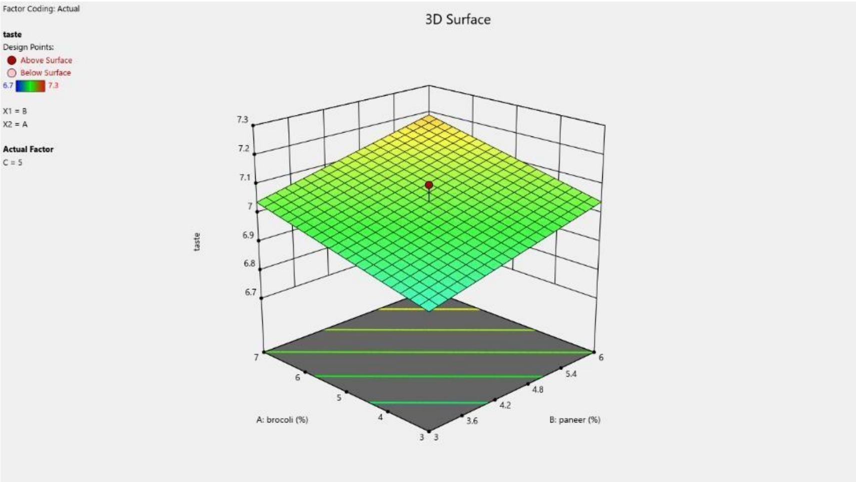


Fig:4.3 b

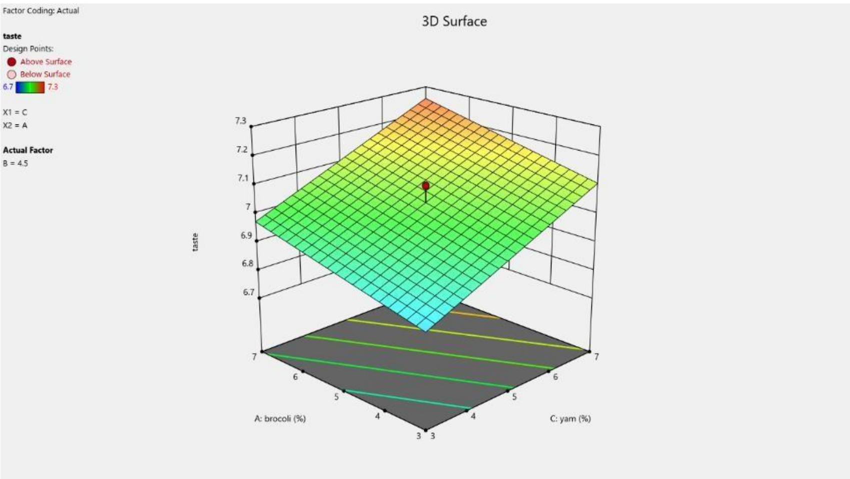


Fig: 4.3 c

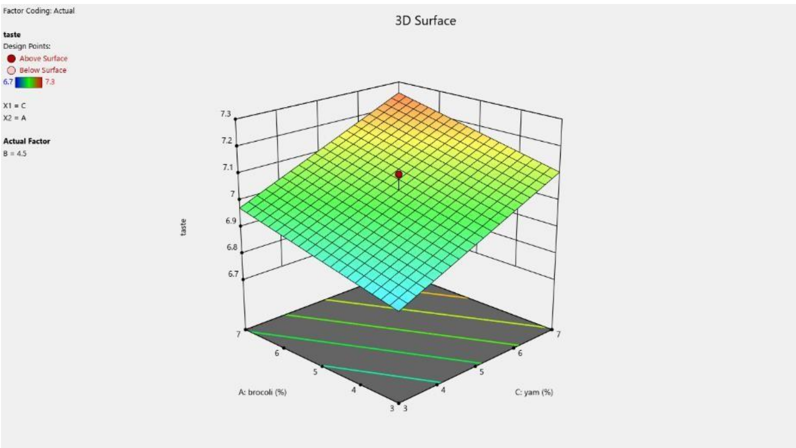


Fig.4.4.Response surface plots for odour score of soup added with broccoli, paneer and yam

Fig;4.4 a

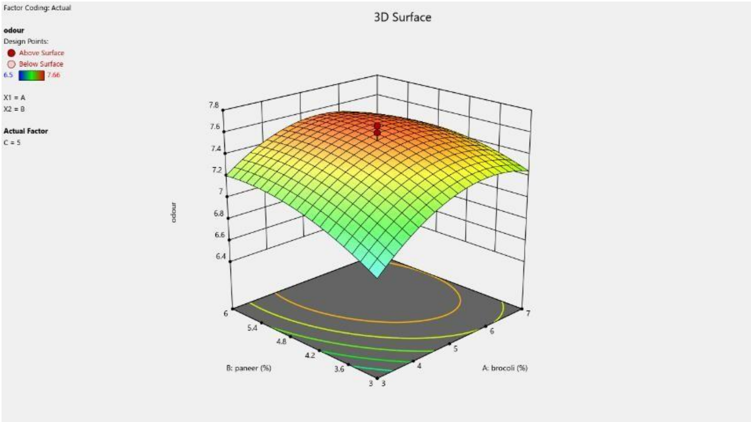


Fig:4.4 b

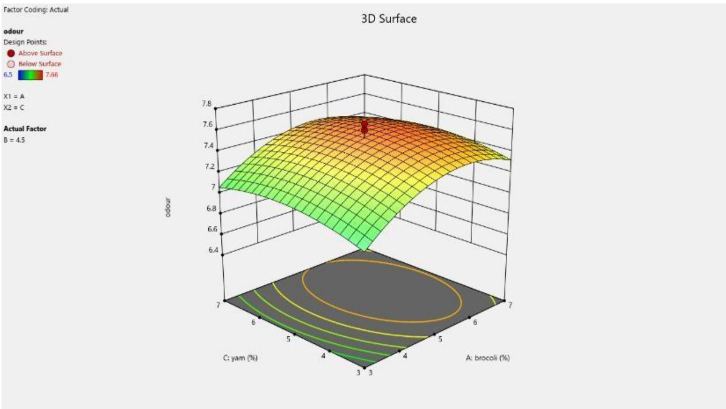


Fig:4.4 c

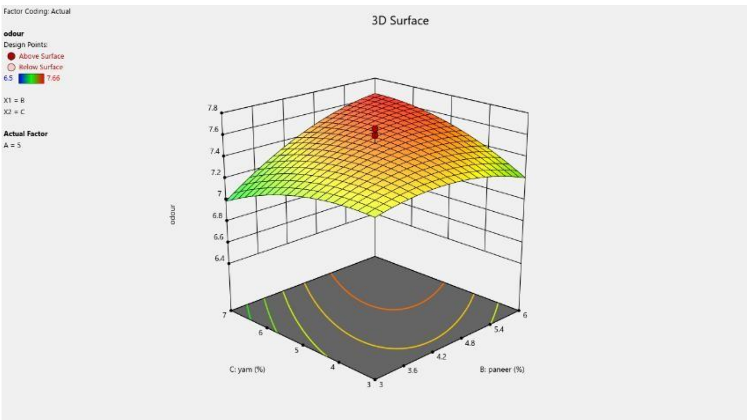


Fig.4.5.Response surface plots for consistency score of soup added with broccoli, paneer and yam

Fig: 4.5 a

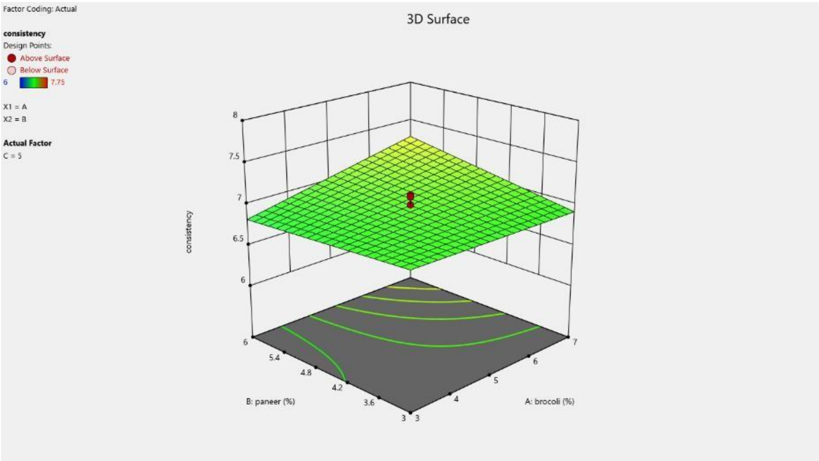


Fig: 4.5 b

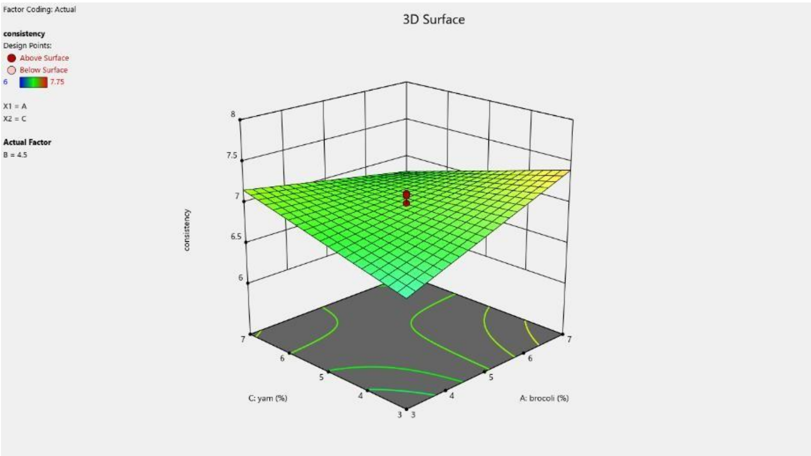


Fig : 4.5 c

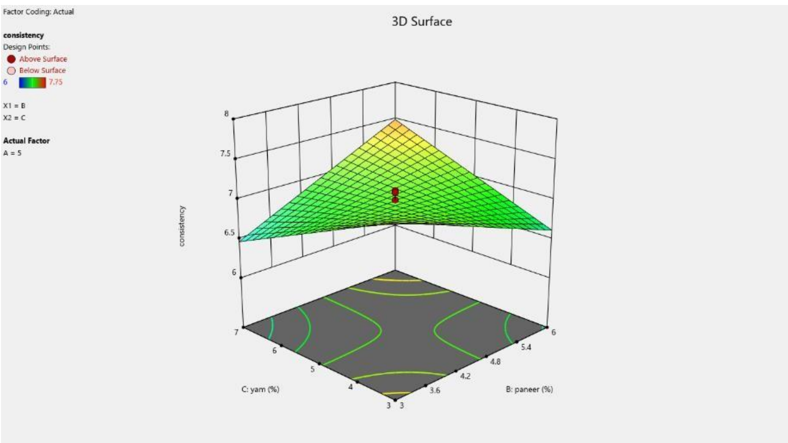


Fig.4.6.Response surface plots for overall acceptability of soup added with broccoli,paneer and yam

Fig: 4.6 a

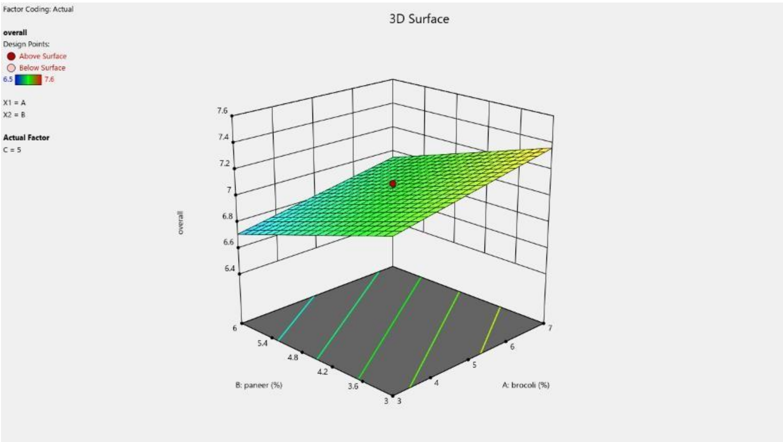


Fig :4.6 b

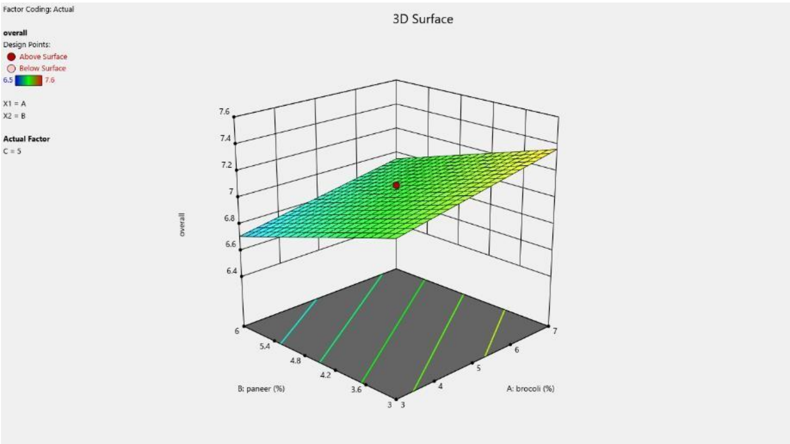


Fig: 4.6 c

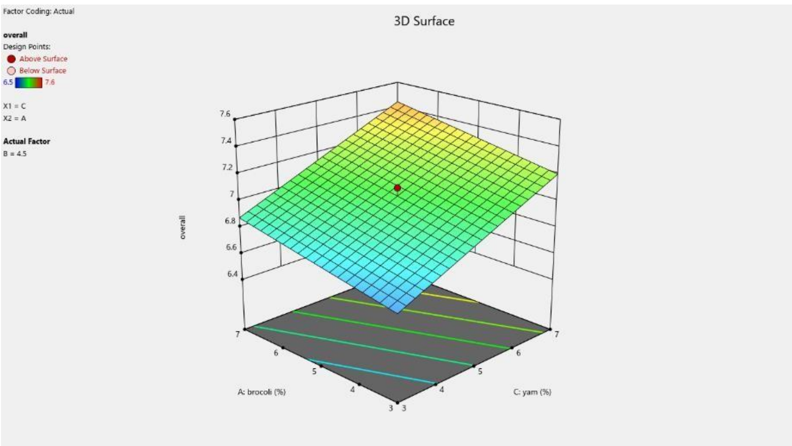


Fig : 4.6 d

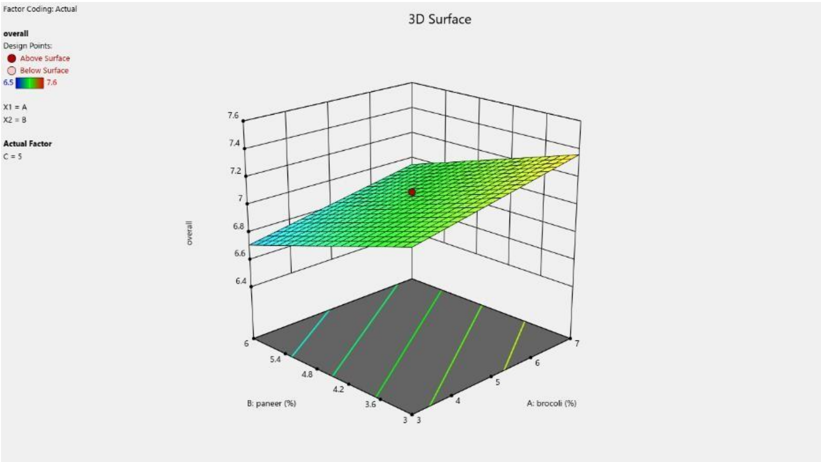
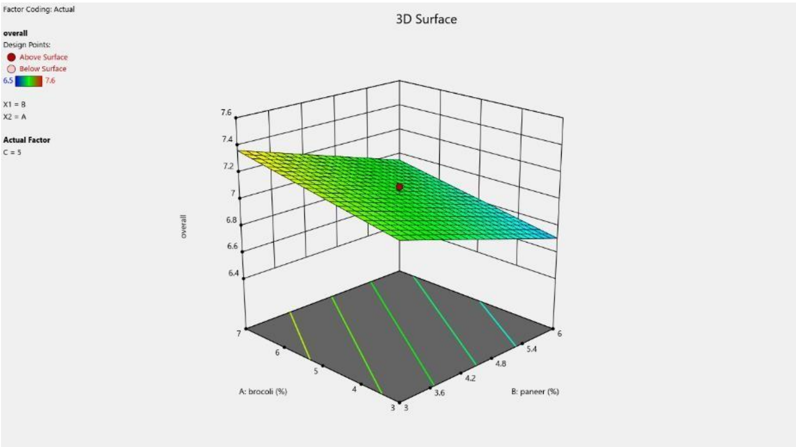


Fig : 4.6e



4.2.2 Optimized solutions and their validation

Numerical optimization was carried out with the goal to obtain best feasible formulation of broccoli,panner and yam in the preparation of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot. The required objectives for all factors as well as responses were selected and different weights were designated to each goal to alter the shape of its specific function of desirability. Other factors were placed in range and responses were kept at maximum during the process of optimization. Solution obtained from RSM software is shown in Table

Table 4.4: Constraints and criteria for optimization of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot with different levels of broccoli, paneer and yam.

Constraints	Goal	Lower Limit	Upper Limit
A:brocoli	is in range	3	7
B:paneer	is in range	3	6
C:yam	is in range	3	7
Colour	maximize	6.8	7.85
Body	maximize	6.25	7.5
Taste	maximize	6.7	7.3
Odour	maximize	6.5	7.66
Consistency	maximize	6	7.75
Overall acceptability	maximize	6.5	7.6

4.5 Solution obtained after response surface analysis

Sl.no	Broccoli	Paneer	Yam	desirability
1	6.96	6.00	7.00	0.857

4.2.3 Verification of the optimum formulations

Functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was prepared by using optimized combinations recommended by RSM and evaluated on the basis of sensory attributes. The results obtained were statistically analyzed using t-test with the corresponding predicted value. Closeness between the observed and predicted values is depicted in Table .It was noted that the difference between the observed values and predicted values were not significant in terms of all attributes.

Table:4.6 Verification of the optimized formulations

Attributes	Predicted value	Observed value	t-value
color	7.82	7.75	8.974^{ns}
body	7.33	7.34	-1.414^{ns}
taste	7.33	7.32	728^{ns}
odour	7.47	7.50	-2972^{ns}
consistency	7.44	7.42	2.449^{ns}

Overall acceptability	7.23	7.25	-1.508^{ns}

4.3 PHYSICO-CHEMICAL ANALYSIS OF FUNCTIONAL WHEY BASED TOMATO SOUP INCORPORATING BROCCOLI,ELEPHANT FOOT YAM,PANEER AND SHALLOT

After optimization the optimized product is subjected to physico chemical analysis. Estimation of moisture, total ash, protein, fat, crude fibre, total carbohydrate, total solids , titratable acidity, pH , viscocity, total soluble solids, color, antioxidant were included in the analysis part.

Table : 4.7 Physico Chemical analysis of soup

Parameter	**CONTROL SOUP**	**SAMPLE SOUP**
Moisture	89.28%	91.45%
Total ash	1.54%	1.59%
Protien	0.28%	0.31%
Fat	0.13%	0.16%
Crude fiber	0.68%	0.73%
Total carbohydrates	8.09 %	5.76 %
Total solids	10.72	8.5
Titratable acidity	0.063	0.081
pH	4.6	4.9
Viscocity	150 cps	150 cps
Total soluble solids	8°Brix	10° Brix

Color characteristics

The perception of color determines the acceptability off the product. Color characteristics of soup standardized in this investigation was measured in terms of L*, a* and b* valuesby Hunter colorimeter (model D25L-9. Hunter Associates Lab, Inc.). Soup was scanned at three different locations. The Observation made for L*, a* and b* were 78.073 2.08 and 18.486 respectively.

Table : 4.8 color characteristics

	L	a*	b*
control	47.28 ±1.75	14.29±0.27	30.93±2.44
sample	54.50±0.96	10.26±1.34	28.63±1.59

L* represents the brightness from white (100) to black (0)

a* represents the red to green color

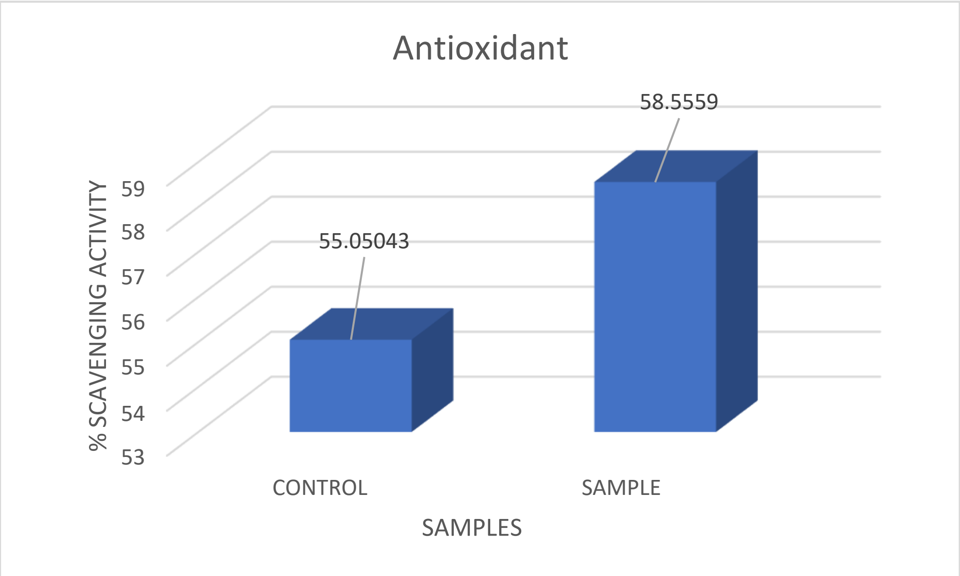
b* represents the yellow to blue color

Antioxidant

Table :4.9

CONTROL	55.05043
SAMPLE	58.5559

Fig.4.7 graph of antioxidant



4.4.COST OF PRODUCTION

The costs incurred when the soup samples were being prepare were calculated on the basis of price of raw materials and processing charges. Other costs like convenience charges and miscellaneous charges were also added. It is the sum total of all the fixed and variable costs.

Table : 4.10 cost analysis

Sl. No	Particulates	Price per Kg of raw materials	Selected sample Soup	
1.	**Raw material**		**Quantity (g)**	**Cost (Rs.)**
	Broccoli	95/-	7	0.665/-
	Elephant foot yam	53/-	7	0.371/-
	Garlic	155/-	1.5	0.232/-
	Ginger	130/-	1.5	0.195/-
	Paneer	140/-	6	0.84/-
	Salt	25/-	1	0.025/-
	Shallot	95/-	3	0.285/-
	Tomato	30/-	25	0.75/-
	Whey	28/-	75	2.1/-
	Total raw materials cost			
2.	**Miscellaneous charges**			10/-
	Total charge			15.46/-

5.DISCUSSION

Soup is served warm,which in liquid form. In this current study, attempts were taken to development of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot. The data obtained during the course of study was statistically analysed and the results are discussed in this chapter.

5.1 SELECTION OF MAXIMUM AND MINIMUM LEVELS OF BROCCOLI,PANEERAND YAM FOR THE PREPARATION OF SOUP

5.1.1 Selection of levels of broccoli in Soup

Broccoli is added in the soup by cutting it into small pieces. Initial and the preliminary trials revealed that **lower** levels of broccoli in Soup is acceptable. The minimum and maximum levels of broccoli in Soup was selected as 3 and 7 respectively

5.1.2 Selection of levels of paneer in soup

Paneer was added in the Soup by cutting it into small pieces From the preliminary trials it was understood that lower levels of paneer was acceptable in the product. The minimum and maximum levels of addition of paneer were selected as 3 and 6 respectively.

5.1.3 Selection of levels of elephant foot yam in soup

Elephant foot yam was added in the Soup by grated shreddes. From the preliminary trials it was understood that lower levels of yam was acceptable in the product. The minimum andmaximum levels of addition of yam were selected as 3 and 7 respectively.

5.2 OPTIMIZATION OF QUANTITY OF BROCCOLI, PANEER AND ELEPHANT FOOT YAM BY RESPONSE SURFACE METHODOLOGY

5.2.1 Effect of Different Levels of Broccoli,paneer and yam on the Sensory Attributes of Soup.

The minimum and maximum levels of broccoli,paneer and yam were selected as 3 and 7 per cent, 3and 6, 3and 7, respectively, from the statistical analysis of preliminary trial data. On feeding these levels to RSM software, the output showing upper and lower limits of ingredients and the central composite rotatable design of three factors constituting 20 runs including lower and upper limits were obtained. The responses of the sensory attributes are exhibited in the table.

5.2.2 Diagnostic Check of the Quadratic Model

In the quadratic model recommended by RSM, F values for all the sensory characteristics were greater than tabled F-values ($p<0.01$) showing the developed model is significant. The coefficient of determination (R2) for colour, body, taste, odour, consistency and overall acceptability was found to be 0.9271, 0.9018, 0.9027, 0.9060, 0.9086 and 0.9474 respectively**,** table 4.3 revealed that the quadratic model indicated more than 80 per cent of the deviation in the data. The test of the lack of fit was found to be non-significant in all the cases and it was obvious that the model is valid for forecasting the sensory properties of soup prepared with any group of variables within the limit appraised. A value above 0.8 indicates that the model is satisfactory and that more than 80 per cent of the variation in the experiment data is depicted by the quadratic fitted model. In the present study, high adequate precision values of 24.93, 18.86, 24.30, 9.63, 18.62, 33.80 were observed for all the models, the optimum level of adequate precision.

5.2.2.1 Effect on Colour

The sensory scores obtained for the colour of soup ranged from 6.8 to 7.85 standard run 8 have got the maximum score while minimum score obtained for the standard run 5. By successive regression analysis, quadratic model for colour was obtained. The effect of three factors (broccoli,paneer,yam) on colour is detailed in the table 4.2. Acceptance of the response, colour to guide the design is indicated by the value obtained for the determination coefficient (R2) 0.9271 with satisfactory precision 24.93. Since the F value for lack of fit test was non-significant, it was clear that the model is authentic enough for forecasting the soup.

5.2.2.2 Effect on Body

The sensory scores obtained for the body of soup ranged from to 6.25 and 7.5 standard run 2 have got the maximum score while minimum score obtained for the standard run 3. By successive regression analysis, quadratic model for body was obtained. The effect of three factors (broccoli,paneer,yam) on body is detailed in the table 4.2. Acceptance of the response, body to guide the design is indicated by the value obtained for the determination coefficient (R2) 0.9018 with satisfactory precision 18.86. Since the F value for lack of fit test was non-significant, it was clear that the model is authentic enough for forecasting the soup.

5.2.2.3 Effect on Taste

The sensory scores obtained for the taste of soup ranged from to 6.7 and 7.3 standard run 8 have got the maximum score while minimum score obtained for the standard run 13. By successive regression analysis, quadratic model for body was obtained. The effect of three factors (broccoli,paneer,yam) on taste is detailed in the table 4.2. Acceptance of the response, taste to guide the design is indicated by the value obtained for the determination coefficient (R2) 0.9027 with satisfactory precision 24.3005. Since the F value for lack of fit test was non-significant, it was clear that the model is authentic enough for forecasting the soup.

5.2.2.4 Effect on Odour

The sensory scores obtained for the odour of soup ranged from to 6.5 and 7.66 standard run 8 have got the maximum score while minimum score obtained for the standard run 9. By successive regression analysis, quadratic model for odour was obtained. The effect of three factors (broccoli,paneer,yam) on odour is detailed in the table 4.2. Acceptance of the response, odour to guide the design is indicated by the value obtained for the determination coefficient (R2) 0.9060 with satisfactory precision 9.6312. Since the F value for lack of fit test was non-significant, it was clear that the model is authentic enough for forecasting the soup

5.2.2.5 Effect on Consistency

The sensory scores obtained for the consistency of soup ranged from to 6 and 7.75 standard run 2 have got the maximum score while minimum score obtained for the standard run 3. By successive regression analysis, quadratic model for odour was obtained. The effect of three factors (broccoli,paneer,yam) on consistency is detailed in the table 4.2. Acceptance of the response, consistency to guide the design is indicated by the value obtained for the determination coefficient (R2) 0.9086 with satisfactory precision 18.6232. Since the F value for lack of fit test was non-significant, it was clear that the model is authentic enough for forecasting the soup

5.2.2.6 Effect on Overall accecptability

The sensory scores obtained for the overall accecptability of soup ranged from to 6.5 and 7.6 standard run 6 have got the maximum score while minimum score obtained for the standard run 3 . By successive regression analysis, quadratic model for overall accectability was obtained. The effect of three factors (broccoli,paneer,yam) on overall accectability is detailed in the table 4.2. Acceptance of the response, overall accectability to guide the design is indicated by the value obtained for the determination coefficient (R2) 0.9474 with satisfactory precision 33.8685. Since the F value for lack of fit test was non-significant, it was clear that the model is authentic enough for forecasting the soup

5.2.2 Optimized Solutions and their Validation

The constraints and criteria that had been generated by RSM for the optimization of Soup is given in the table . During the optimization process all the factors were kept in range and the sensory scores were kept at maximum. The suggested solution for the preparation of soup is presented in the **table .** The optimum values selected were 6.96 % for broccoli ,5.99 % for paneer and 6.99 % for yam and the solution got a desirability of 0.857. The predicted values for sensory score responses, colour, body, taste, odour, consistency and overall acceptability of soup were 7.83, 7.33, 7.33, 7.47, 7.44 and 7.23, respectively.

5.2.3 Verification of Optimum Formulations

The soup was prepared by the addition of the ingredients at the level recommended by RSM. The obtained scores were subjected to statistical analysis and the result is shown in the table**.** It is observed that there is no significant difference between the predicted and observed value with regard to all sensory attributes.

5.3 PHYSICO-CHEMICAL ANALYSIS

Physico-chemical analysis of optimized product was analysed. It includes estimation of moisture, total ash, protein, fat, crude fibre, total carbohydrate, total solids , titratable acidity,pH ,viscocity,total soluble solids,color,antioxidant. The optimized product have got 91.45 per cent for Moisture, 8.5 per cent for Total Solids, 1.59 per cent for Ash, 0.16 per cent for Fat ,0.31 per cent for Protein , 0.73 per cent for crude fibre, 5.76 per cent for carbohydrate 10 for total soluble solids ,4.9 for pH , 150Cp for viscocity and 0.081 titratable acidity. As there is control sample available, so, comparative analysis is possible with the optimized product .

The moisture content in functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 91.45% and Control soup had 89.28% . Moisture content increase when addition of broccoli,paneer and yam. Similar results were reported in Banerjee(1994) the range was shown 90.1% to 92.3%.

The ash content in functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 1.59% and control soup had 1.54% . The highest value was found in functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot.

The protein content of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 0.31% and control soup had 0.28%

The fat per cent of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was0.16% and control soup had 0.13%.

The crude fibre of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 0.73% and control soup had 0.68%.

Total solid found in functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 8.5 and control soup has 10.72.

Titratable acidity of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 0.081% and control soup had 0.063%

pH of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 4.9 and control soup has 4.6 .

The viscosity was determined using a spindle number 3 at speed 20 rpm .it was measured in centipoise by Brookfield viscometer. The value of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 150 cps and control soup had 150 cps. It was found that same viscosity for each sample.

The total soluble solids of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was and control soup had 10° brix.

The study of color characteristics is important to determine the overall acceptability of the product. The reading obtained for the color parameters of soup are described in table 4 .9 .

Table : 5.1

The % scavenging activity of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot was 58.55mg/ml and control soup had 55.05mg/ml.In this study incorporating broccoli and tomato in soup shows that higher antioxidant property.

5.4 COST OF PRODUCTION

According to results of cost analysis final cost of the product was calculated as Rs.15.46/-.

6.SUMMARY

This study aimed to Development of functional whey based tomato soup incorporating broccoli, elephant foot yam, paneer and shallot. The addition of broccoli, yam,paneer helps in improving the health benefits and overall quality of the product.

Central Composite Rotatable Design of RSM was used to optimize the various levels of broccoli, paneer and yam on sensory characteristics such as colour,body, taste, odour, consistency and overall acceptability all had coefficients of determination (R2) of 0.92, 0.90, 0.90, 0.90, 0.90 and 0.94 respectively, indicating that the fitted quadratic model explained more than 80 per cent of the variation in the experimental data

The model is satisfactorily accurate for forecasting the sensory properties of Soup made with any combination of the variables within the range estimated. Soup was prepared by adding broccoli,paneer,yam at optimized levels of 6.96 %,6 % and 7% respectively while other ingredients such as whey, tomato, water, shallot, ginger, garlic and salt are at fixed level .The highest desirability of 85 per cent was obtained with the levels 6.96 per cent for broccoli , 6 per cent for paneer and 7 per cent for yam .

The optimized Soup was evaluated for its physico-chemical attributes. The optimized soup was found that 91.45 per cent for Moisture, 8.5 per cent for Total Solids, 1.59 per cent for Ash, 0.16 per cent for Fat ,0.31 per cent for Protein , 0.73 per cent for crude fibre, 5.76 percent for carbohydrate 10 for total soluble solids ,4.9 for pH , 150Cp for viscocity , 0.081 % titratable acidity and % scavenging activity of 58.55mg/ml.

The product development of such valuable products was opportunities for the dairy industry to develop functional foods by utilizing whey and by incoprating broccoli, paneer and yam into tomato whey soup were enhance it health benfits and reduce the burden on environment.

The ingredients used to make soup have no adverse effect on human health. So, the hypothesis was null which means our assumptions were true.

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