

**STUDIES ON DEVELOPMENT AND QUALITY
ASSESSMENT OF VEGAN BEVERAGE BY USING
SOY, COCONUT AND ALMOND MILK**

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B. Tech (Food Technology)

MASTER OF TECHNOLOGY

IN

FOOD TECHNOLOGY



DEPARTMENT OF FOOD ENGINEERING

COLLEGE OF FOOD TECHNOLOGY, PARBHANI

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PARBHANI - 431 402 (M.S.) INDIA

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BY

SHINDE SIDDHESHWAR BHAGWANRAO

B. Tech (Food Technology)

A thesis submitted to

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani

in partial fulfillment of the requirement for the degree of

MASTER OF TECHNOLOGY

IN

FOOD TECHNOLOGY



DEPARTMENT OF FOOD ENGINEERING

COLLEGE OF FOOD TECHNOLOGY, PARBHANI

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PARBHANI - 431 402 (M.S.) INDIA

2022

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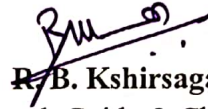
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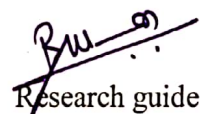


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ABBREVIATIONS USED

Abbreviation		Elaboration
@	:	At the rate
%	:	per cent
L	:	Length
W	:	Width
T	:	Thickness
CD	:	Critical difference
Cm	:	Centimeter
SE	:	Standard error
Mm	:	Milli meter
Mg	:	Milli gram
Mm	:	Micrometer
G	:	Gram
Kg	:	Kilogram
°C	:	Degree celsius
P	:	Density
<i>et al.</i>	:	Et alibi (and associates)
Hr	:	Hour
i.e..	:	That is
K.cal	:	Kilo calorie
WAC	:	Water absorption capacity
FOS	:	Fructooligosaccharide
W.r.t.	:	With respect to
No.	:	Number
Etc	:	Etcetera
CFU	:	Colony forming unit
CVD	:	Cardio vascular disease
LDL	:	Low density lipoprotein
PP	:	Poly propylene
PET	:	Poly ethylene terephthalate
Min	:	Minute

ml	:	Milliliter
Rs	:	Rupees
Sec	:	Second
N	:	Normality
WHO	:	World health organization
H ₂ SO ₄	:	Sulfuric acid
NaOH	:	Sodium hydroxide
Ca	:	Calcium
Na	:	Sodium
Cu	:	Copper
Zn	:	Zinc
Fe	:	Iron
K	:	Potassium
Mg	:	Magnesium
pH	:	Potential of hydrogen

THESIS ABSTRACT

Title of thesis	STUDIES ON DEVELOPMENT AND QUALITY ASSESSMENT OF VEGAN BEVERAGE BY USING SOY, COCONUT AND ALMOND MILK
Name of candidate	Shinde Siddheshwar Bhagwanrao
Research Guide	Dr. R. B. Kshirsagar
Department	Food Engineering
College	College of Food Technology V.N.M.K.V. Parbhani
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ABSTRACT

Plant based or non-dairy milk beverages is the fastest growing sector in new food product development category of nutraceutical and functional food market. At the moment, soy milk, coconut milk, oat milk, almond milk, millet milk etc. are the most popular milk substitutes all over the world. The present research was focused on development and quality assessment of vegan beverage by using soy, coconut and almond milk. The study focused on improving and diversifying the food and nutrition status of soy milk prepared by two different methods. First one focused on 28 hours germinating the soybeans and later one based on soaking and cooking of soybean in 0.5% sodium bicarbonate solution prior to milk extraction. The formulation for development of vegan beverage by using soy, coconut and almond milk on the basis of sensory evaluation. The extracted milks were blended in different concentrations. By using germinated soy milk with coconut and almond milk. The treatments were C₀ (untreated soy milk), A₁ (80 % soy milk + 10 % coconut milk + 10 % almond milk), A₂ (70 % soy milk + 15 % coconut milk + 15 % almond milk), A₃ (60 % soy milk + 20 % coconut milk + 20 % almond milk). Other formulation was made by using sodium bicarbonate treated soybean milk. The treatments are B₁ (80 % soy milk + 10 % coconut + 10 % almond milk), B₂ (70 % soy milk + 15 % coconut milk + 15 % almond milk), B₃ (60 % soy milk + 20 % coconut milk + 20 % almond milk).

All treatments were examined for the organoleptic evaluation by trained panel members. Formulation A₃ and B₃ were selected for the proximate analysis on the basis of mean sensory score. Treatment A₃ was found significant over B₃ in the physico-chemical profile. The moisture, protein, fat, carbohydrate, ash and dietary fiber of

treatment A₃ was 88.43 ±0.98, 3.20 ±0.04, 5.49 ±0.03, 2.05 ±0.04, 0.79 ±0.09, 0.73 ±0.01 Per cent respectively and that of B₃ was 89.00 ±0.4, 2.98 ±0.03, 5.90 ±0.08, 2.41 ±0.11, 0.68 ±0.02, 0.63 ±0.05 Per cent respectively. In the developed technology A₃ sample again optimised with two different sweeteners namely Fructooligosaccharide and jaggery. Sensory evaluation was standardized for addition of FOS and jaggery as 12 gm FOS and 8 gm jaggery was found suitable for in A₃F₂ and A₃J₂ respectively. Both the treatments were analyzed for proximate analysis. The moisture, protein, fat, carbohydrate, ash and dietary fiber for A₃F₂ was 80.44 ±0.92, 2.81 ± 0.20, 4.83 ±0.46, 5.04 ±0.72, 0.67 ±0.89, 6.40 ±0.91 Per cent respectively and that of A₃J₂ was 79.91 ±0.81, 3.01±0.51, 4.93 ±0.46, 9.84 ±0.82, 1.98 ±0.47, 0.65 ±0.62 Per cent respectively. Treatment A₃F₂ (60 % germinated soy milk + 20% coconut milk + 20% almond milk + 12 gm FOS) was significant in dietary fiber and low-fat content and was rated quite good in terms of overall acceptability on the basis of proximate, microbial and sensory evaluation.

Key words: Soyabean, Germination, Sodium Bicarbonate, Soy Milk, Coconut Milk, Almond Milk, Vegan Beverage.

CHAPTER- I
INTRODUCTION

CHAPTER- I

INTRODUCTION

Milk is one of the most habitually consumed food by the human population from ancient times, however, as people's attitudes toward animal rights and their preferences for lactose-free food change, more individuals are turning vegan, which is boosting the market for plant-based milk all over the world. Due to its nutritional content and variety in satisfying appetite. However, modern clinical investigations have shown that various milk ingredients are linked to harmful health effects such cow milk allergy (CMA), lactose intolerance (LI), anaemia, and coronary heart disease, which has caused alarm among the risk-averse and health-conscious public (Thorning *et al.*, 2016). For those seeking dairy-free options, plant-based milk can be a decent option and consumers are more interested in choosing vegan diets over traditional mammalian milk (Kundu *et al.*, 2018).

India still ranks first in both production and consumption of dairy products made from animal sources. With 4 per cent of the country's economy, it is one of the largest agri-businesses in India. As per the value-added products driving market expansion, the animal-derived dairy business in India has developed at a 12% CAGR over the last 5 years.

On the other hand, despite its modest popularity, plant-based dairy is spreading throughout the globe. With Indian customers, plant-based milks including soy and almond milk have made encouraging inroads. Plant-based dairy is expected to increase at a CAGR of 20.7% in India, from an estimated \$21 million in 2016 to \$63.9 million in 2024, compared to the \$140 billion animal-derived dairy business (*GM insights*). Vegans have found success using non-dairy milk substitutes. People who are allergic to cow's milk or lactose are also able to consume them. Most plant-based milks are low in fat and do not contain cholesterol, which is ideal for persons with digestion issues or those who are concerned about their weight.

Non-dairy milk substitutes are liquids made by soaking, mixing and grinding plant material in water, draining the water, and then combining it with clean water. After filtration, the mixture has an appearance and viscosity that are somewhat similar to that of cow milk. Extracting replacement milk involves using a variety of plant

sources, including oats, rice, soy, peanuts, cowpeas, almonds, and coconut (Sethi *et al.*, 2016). As consumers become more aware of and sensitive to the mistreatment of animals done during the manufacturing of milks, there is a growing market demand for non-dairy milks (Sethi *et al.*, 2016). The ecology appears to be less negatively impacted by the manufacturing of non-dairy milks (McCarthy *et al.*, 2017). The sensory qualities and nutritional makeup of these plant-based milks are distinct from those of cow's milk. To enhance the final product's quality, pre-treatments including soaking, peeling, and boiling can be carried out (Silva *et al.*, 2020). The source from which the milk was extracted determines the nutritional makeup of such milks. Milks that have been derived from more than two sources are therefore considered to have better nutritional value. The cultivated area for Soybeans in India in 2021-22 was 12.2 million hectares, a little increase from 12.1 million hectares in 2020-21 (*Ministry of agriculture 2021*). All demographic groups seek for beverages to relieve their thirst and enjoy a cool drink in addition to its health and medicinal benefits (Thakur *et al.*, 1999). The beverage industry has such high potential for profit, individuals who are involved in the promotion of dairy products should pay close attention to any new innovations in this sector (Mann 1998).

Soybean is an extensively grown legume all over the world which is exceedingly consumed by people due to its extraordinary nutritional value. According USDA publication and the Soybean Processors Association of India (SOPA), total Soybean production in the financial years 2020–21 was 364.66 MMT, with India accounting for 11.200 MMT, ranking fifth in the world (*USFDA 2021*) Soy protein is highly digestible and includes almost all of the necessary amino acids as well as minerals including calcium, magnesium, potassium, copper, iron, and zinc. (Liu 2004) studied that about soybeans are made up of carbohydrates, 40% of them are proteins, 20% are oils, and 5% are ash

Mono-unsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) found in Soybeans are important and good for cardiovascular health (Schwingshackl & Hoffmann 2012). Isoflavones, which are found in Soybeans in amounts up to 1g/kg, are another functionally active component. Isoflavones offer protection from a wide range of illnesses, including cancer, osteoporosis, and cardiovascular disease. The isoflavone that is most prevalent in Soybeans is genistein. In addition to isoflavones and protein, soy also contains fibre, B vitamins, calcium,

iron, and zinc. Pectic polysaccharides, which make up the majority of soy fibre, are readily digested by gut microbes (Yamaguchi *et al.*, 1996). Soy's oligosaccharides function as prebiotics. (Yang *et al.*, 2011).

Raw Soybean consumption is unhealthy because it includes endogenous enzyme inhibitors that make it difficult to digest. As a result, thermal processing is necessary to enhance the quality of soy-based foods and drinks since heat inactivates inhibitors and lectins (Friedman and Brandon 2001). The nutritional content of soy milk prepared from 28 hrs germinated Soybeans was increased, and its physical and chemical qualities were equivalent to those of regular soy milk. The current strategy offers a practical methods for development of soy-based products in both domestic and industrial contexts. (Jiang *et al.*, 2013).

The coconut is a significant fruit tree in the globe, supplying sustenance for millions of people, especially in tropical and subtropical countries, and is frequently referred to as the "tree of life" due to its numerous uses (DebMandal and Mandal 2011). Coconut is one of the most significant tree crops in the tropical areas of the world, it provides food and shelter for millions of people. More than 93 nations produce coconut trees, which cover an area of 11.95 million hectares and yield 57,510 million coconuts a year (Jayasekara and Gunathilake 2007).

According to the survey of *India brand equity foundation*, India is one of the top exporters of coconuts, and during the years 2020–21, it accounted for around 34% of global production. Approximately Rs. 307,498 million (US\$ 3.88 billion) of the nation's gross domestic product comes from the crop. For more than 12 million people in India, the coconut palm offers food security and prospects for a living. Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh account for the majority of India's coconut production, which comprises 90.04% of the nation's production and 89.13% of its area. Gujarat, West Bengal, and Orissa are some other states in the India that grow coconuts.

Coconut milk is a significant part of diet of the society in coconut producing nations like West soma, Indonesia, Sri Lanka, Thais, Singapore, Philippines, and India. In Indonesia, coconut-milk is termed as Santan-Santan, in Sri Lanka 'Polkiri', in Philippines 'Gata' and in English sometimes 'Coconut creams. Many of the classic South East Asian dishes, particularly those from India, require coconut as a key

component. The nutritional effects of coconut oil's fat are comparable to those of mother's milk's fat.

Coconut milk is a milky-white emulsion that separates into two clearly identifiable phases at first: a heavy aqueous phase and a lighter cream phase. The coconut emulsion system is comparable to the one in cow's milk, although little is known about its nature. Coconut milk, which is made by extracting the milk from the flesh of the coconut, has a high saturated fat content but is healthier than other products with saturated fat since the body can readily metabolise it. It has anti-microbial, anti-bacterial, anti-viral, anti-fungal, and anti-carcinogenic activities. Lauric acid, the primary saturated fat it contains, is likewise present in mother's milk and has been demonstrated to support immune system health, bone health, and brain development (Ahmed *et al.*, 2019).

The primary attributes of coconut milk are its distinctive nutty flavour and nutritional benefits. According to the literature that has been studied, the ranges for moisture, fat, protein, ash, and carbs are, respectively, 47.53 to 56.3, 27.0 to 40.0, 2.6 to 4.4, 0.9 to 1.3, and 5.0 to 16 g (Bolange 2006). The typical mechanical process for making coconut milk begins with shelling the nut and removing the coconut meat, which is then cleaned and grated. The oil, milk, and aromatic components are extracted by mixing with warm water (Belewu and Belewu 2007). The yield of producing coconut milk is significantly impacted by variables like grinding time, incubation time, and Viscozyme-L enzyme. To be more specific, the yield is indirectly proportional to the effect of grinding time, and this effect is only marginally influenced by the interaction of the enzyme with the incubation time (Agarwal and Bosco 2014).

Lauric acid is also beneficial for enhancing the immune system and keeping blood vessels supply. Vitamin E, one of the antioxidants found in abundance in coconut milk, aids in the battle against ageing. Consuming coconut milk is rarely linked to allergic responses. Additionally, coconut milk aids with digestion, nourishes the skin, and has cooling effects (Tulashie *et al.*, 2022). Despite all the health advantages, the presence of saturated fats restricts consumption. Commercially, it is offered under the brand names Blue Diamond (USA), Silk (USA), etc.

Almonds are said to be an excellent source of proteins, dietary fibre, health-promoting (USFA) unsaturated fatty acids, vitamin E, and other vitamins. They are very low in (SFA) saturated fats and contain no cholesterol (Miraliakbari and Shahidi, 2008).

Prunus dulcis is the binomial name for the almond. Almonds are utilised in a variety of foods, including beverages, pastes, butter, snacks, and baked items that are based on almonds. According to reports, the *Prunus* genus has intriguing biological characteristics like sedative, anti-inflammatory, anti-hyperlipidaemic, antitumor, and antioxidant actions (Sang, *et al.*, 2002). Almonds are known to provide health benefits for human blood cholesterol levels and lipoprotein profiles in addition to their nutritional value. Additionally, consumption of almonds as snacks and in hyperlipidemic participants' diets dramatically decreased coronary heart disease risk factors.

Since almonds are the third-largest crop in America and California was currently the top producer, almond milk is a strong rival to dairy milk. Half the fat and a third of the calories in milk are contained in almond milk. It can have the same amount of calcium and other minerals while containing no lactose. The fact that it has an almond-like flavour and can be sweetened with a variety of low-calorie sweeteners is another reason why many people love it (Young *et al.*, 2004).

Colloidal dispersion made from almonds and water is known as almond milk. This plant-based beverage is intended for users with lactose intolerance, cow milk allergies, and those looking for plant-based beverages as a dairy-free option (Novak *et al.*, 2008).

Almonds are a rich supply of minerals and a great amount of tocopherol (36.4%), which is essential for preventing free radical reactions and, consequently, oxidative stress. It has a high fibre content (13.2%) in addition to being fortified with minerals including magnesium (19.5%), copper (16.0%), and phosphorus (13.4%). Almonds have a protein content of about 25%, with extremely high quantities of arginine. The majority of the protein is found as AMP or amandin. Almonds have a significant amount of fat (49.4% of weight), but what makes them stand out is their high level of MUFA (67%), which may have positive effects on heart health. In addition, almonds contain phytosterols and polyphenols with cardioprotective

properties, including campesterol, stigmasterol, sitostanol, and campestanol (Kundu *et al.*, 2018).

Almonds are regarded as one of the "Brain-food" (together with hazelnut and walnut), since they guarantee a healthy brain by fostering mental alertness, attention, recall abilities, memory, and helps to achieve decent sleep when consumed at night (Gorji *et al.*, 2018).

The novel alternative sweeteners, FOS from sucrose, have a lot of enticing characteristics, including low calories, no carcinogenicity, safety for diabetics, and bifidus-stimulating activity. The short fructose chains that make up FOS are beneficial for a number of things. They belong to the class of carbohydrates called oligosaccharides (Yun, 1996). Because of the rising demand for wholesome, high-quality foods, FOS have emerged as a key player in the functional food sector. A variety of items, including dairy, bakery, beverages, jams, jellies, candies, chocolates, breakfast cereals, meat, ice cream, and confectionery contain it due to its functional qualities and health advantages (Kherade *et al.*, 2021).

One of the main groups of bifidogenic oligosaccharides are nondigestible carbohydrates called FOS (Flores *et al.*, 2016). FOS are a class of homologous oligosaccharides with β (2 \rightarrow 1) fructosyl- fructose glycosidic linkages. They are also referred to as oligofructose, oligo fructans, fructose oligomers, fructans, or glucofructans (Guo *et al.*, 2016). Using *Aspergillus Niger* cells immobilised in calcium alginate gel, Meiji Seika Kaisha Co., Tokyo, Japan, made its first commercial breakthrough in the synthesis of FOS in 1984 (Tungland 2003).

In a number of food applications, FOS, which have an approximate 80% water solubility, contribute to raise the product's nutritional value. Due to their larger molecular weight, FOS are more viscous than sucrose at the same dosage, giving them a better mouthfeel and body. The rate of gastric emptying, digesting, and nutritional absorption may be delayed by increased gastrointestinal viscosity. The standardised pH range for FOS is 4.0–7.0, and they exhibit great food stability (Kherade *et al.*, 2021). This was regarded as a good source of dietary fibre in accordance with US FDA recommendations, which state that a good source should include 2.5–4.9 g of fibre (Kumar 2018). Every day intake of 20 g FOS meaningfully reduces basal hepatic glucose production, (Bornet *et al.*, 2002).

Several Food processing businesses have been attempting to obtain the Generally Recognized as Safe (GRAS) designation for utilising FOS with plain, unsweetened dairy products despite the fact that FOS have not yet been commercialised in the United States and Europe. Some consumption statistics make it clear that customer interest in low-calorie food products is rising. 9g Therefore, it is anticipated that FOS consumption in the sugar industry will increase. In Japan, Korea, and various European nations, numerous petitions opposing the use of FOS in foods are now being processed (Stamp, 1990).

Jaggery and khandsari are traditional Indian sweeteners made from sugarcane in addition to sugar. They are also known as Gur in India, Desi in Pakistan, Panela in Mexico and South America, Jaggery in Burma and other African nations, Hakuru in Sri Lanka, and Naam Taan Oi in Thailand (Rao *et al.*, 2007). However, because it operates on a small scale, it is completely exempt from all regulations and taxes that apply to the sugar industry (*Indian Sugar* 2004). The per capita consumption of sweeteners would rise from its present level of 26.47 kg/annum in 2020 AD to around 40 kg/annum (Nerkar, 2004). In contrast to khandsari, jaggery is a healthy food. Minerals range from 0.6% to 10% in it. Iron (11 mg%), calcium (0.4%), magnesium, and phosphorus (0.045%) are significant ones. Additionally, the reducing sugars glucose and fructose (10–15%), protein (0.25%), and fat (0.05%) are all present in jaggery (Kumar, 1999).

Jaggery can be found primarily in three different forms on the market: solid, liquid, and granular. About 80% of the jaggery created in India is produced in solid form, with the other 20% being prepared in both liquid and granular form. The majority of West Bengal and Maharashtra eat liquid jaggery, which is becoming more and more important commercially. Liquid jaggery is used as a sweetening ingredient in foods and beverages in Maharashtra, Gujarat, Kerala, Andhra Pradesh, West Bengal, and Tamil Nadu. It is also used in pharmaceutical formulations (Rao, 2007).

Compared to solid jaggery, which has a higher moisture content (120 g/kg), powder jaggery has a lower moisture content (10–30 g/kg). They did not conduct any experiments to support their claim that powder jaggery would have a longer shelf life than its solid version (Rao, 2007). Making organic and chemical-free jaggery is becoming more and more popular today. Chemicals used in ordinary jaggery include

sodium bicarbonate, ZFS (zinc formaldehyde sulphonylate), sulphur dioxide, calcium carbonate, chemotic, polyelectrolyte, sodium hydrosulphite (hydros), citric acid, hydrogen peroxide, alum, phosphoric acid, etc. These substances serve as clarifiers. The safe limit should be followed when using these chemical clarificants (Hirpara *et al.*, 2020).

Jaggery is frequently referred to as "Medicinal Sugar." It is utilised in pharmaceutical formulations, and regular use of jaggery has been linked to an increase in human life expectancy (Kumar 1999). It has a significant level of phenol (Nayak *et al.*, 2009). Jaggery has higher medicinal and nutritional values as compare to other sweeteners, easily available to the rural people and is highly recommendable by health experts. There are number of applications of jaggery in variety of foods and its use in households makes it a better choice as compared to sugar. Also, jaggery is associated with number of health benefits; which makes it a better choice than sugar (Hirpara *et al.*, 2020). Jaggery industry has been one of the most ancient and important rural-based cottage industries in the country. It provides jobs to the unemployed rural people in their vicinity with minimum capital investment. It is cheaper than white sugar. It also has higher medicinal and nutritional values and easily available to the rural people (Rao, 2007).

In view of the need of dairy free option and plant-based milk to overcome the problems of lactose intolerance and cholesterol rise, along with increase the nutritional profile. Hence, the present research project has been planned to utilize the nutritional, nutraceutical and bioactive component rich plant-based ingredients viz., soy, coconut and almond to prepare vegan beverage with the following objectives.

1. To study the physico-chemical properties of raw material used for vegan beverage.
2. To study the effects of processing treatments on nutritional quality of vegan beverage
3. To study the effects of processing treatments on organoleptic quality of vegan beverage
4. Evaluation of shelf life of prepared vegan beverage
5. Assessment of the energy value and techno-economic feasibility vegan beverage

CHAPTER- II
REVIEW OF LITERATURE

CHAPTER- II

REVIEW OF LITERATURE

Vegan food provides health benefits above and beyond those of a purely nutritional nature. The demand for vegan food is rising as a result of rising awareness among health-conscious consumers. Probiotics, prebiotics, and fibres are all found in plant-based foods. Therefore, using plant-based meals is a wonderful idea to incorporate functionally active components in the diet. Vegan beverage resembling the nature and characteristics of animal milk made from cereal or pulses are an excellent alternative to dairy based milk and help to keep the body healthy and disease-free (Sethi *et al.*, 2016). The scientific literature pertaining to the planned research project has been thoroughly studied and has been presented under following sub headings.

2.1 Physico-chemical properties of raw material

2.2 Effects of processing treatments on nutritional quality of vegan beverage

2.3 Effects of processing treatments on organoleptic quality of vegan beverage

2.4 Evaluate shelf life of vegan beverage

2.5 Energy value and Techno-economic feasibility of vegan beverage

2.1 Physico-chemical properties of raw material

2.1.1 Physico-chemical properties of soybean (*Glycine max*)

Grover *et al.*, (1989) Studied that the majority of the soybean which is harvested in India is used to extract oil, while de-oiled meal is mostly used as animal and poultry feed. Meal or soybeans are rarely processed in this way for immediate human use.

Kahn *et al.*, (1990) discovered that soy milk, which is manufactured from soy beans, has been marketed as a cheap, high-protein beverage in developing countries where the thronging millions of people lack access to affordable animal-based protein meals.

Gandhi *et al.*, (2000) investigated that the leguminosae is the family that includes soybean, *Glycine* is a genus with roughly 10 species and many thousand

variations. The majority of commercially available cultivars have yellow seed coats. Various types also have seed coatings that are green, black, and brown. The primary foods made from soybeans are soymilk, soy paneer, full-fat soy flour, soy splits, soy flakes, extruded products, ready-to-eat snacks, soy sprouts and soy oil, fermented products.

Liu (2004) reported that on average, a dried soybean contained 40% protein, 20% oil, 35% carbohydrates, and 5% ash.

Wandkar *et al.*, (2012) observed that at the moisture level of 7.3 the physical properties of soybean such as length, width, thickness, Geometric mean, Sphericity, thousand kernel weight observed as 6.55 ± 0.27 mm, 5.56 ± 0.26 mm, 4.53 ± 0.24 mm, 5.44 ± 0.22 mm, 0.8324 ± 0.020 , 103.57 ± 0.42 mass/gm respectively. He also investigated that bulk density, true density, porosity and angle of repose was 749.1 ± 3.76 kg/m³, 1250 ± 4.67 kg/m³, 40.07 ± 0.59 %, 26.35 ± 0.69 ° respectively.

Medic *et al.*, (2014) studied that there are two components to a soybean seed: seed coat (hull) and embryo. The embryo, which consists of two cotyledons and an embryonic axis, makes up 90 per cent of the weight of the seed. The embryonic axis is composed of the radicle, hypocotyl, and epicotyl. The cotyledons are the most significant components of the seed from a commercial standpoint since they are a repository for protein and oil.

Bansal and Kaur (2014) analysed the soybean milk from germinated soybeans. The pH, moisture, lipid, protein, and ash contents of raw soybean were observed to be 6.76, 12, 17.67, 39.6, and 5 per cent, respectively. Both non-germinated and germinated soy milk were produced (28 hrs). The results showed that the percentages of moisture, fat, protein, carbohydrate, and ash in milk derived from non-germinated soy were 93, 1.51, 2.64, and 0.65 per cent respectively, whereas the percentages in milk derived from germinated soy were 95, 1.28, 3.11, 0.50, and 0.56 per cent respectively. Protein digestibility was improved, while the amount of fat and carbohydrates were reduced, due to germination.

O'Keefe *et al.*, (2015) revealed that two primary proteins in soybean are 11S glycinin and 7S -conglycinin, both of which have globular structures.

Sigh *et al.*, (2016) reported that soybean (*Glycine max*), a leguminous plant which contains 40 % high-quality protein, 20 % oil, and other nutrients, has a significant potential to treat protein-calorie malnutrition in India at a reasonable cost.

Niyibituronsa *et al.*, (2019) reported that soybean is very nutrient dense and good source of the mineral's such as calcium (276 mg/100 g), magnesium (280 mg/100 g), potassium (1,797 mg/100 g), iron (16 mg/100 g), and zinc (4.8 mg/100 g), and contain about 40% protein, 20% of which are primarily unsaturated fats.

Sharma *et al.*, (2020) reported that 100g of soybeans include 14g of protein, 5g of carbohydrate, and 7g of fat. Additionally, each 100g contains minerals like 12% calcium, 20% iron, and 23% magnesium. Soybean contains 15% thiamine, 8% riboflavin, 21% niacin, and other vitamins per 100g. In addition to these, soybeans include phospholipids, which are necessary for the improvement of brain function.

SOPA (2021) According to Department of Agriculture and Farmers Welfare as of September 17th, 2021, India's acreage planted with soybeans for the 2021–22 growing season was 121.76 lakh hectares, up from 121.20 lakh hectares for the 2020–21 growing season. Madhya Pradesh led the states with 55.84 lakh ha, followed by Maharashtra (46.01 lakh ha), Rajasthan (10.62 lakh ha), Karnataka (3.82 lakh ha), Gujarat (2.24 lakh ha), and Telangana (1.51 lakh ha). The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, and Telangana. According to the first advance estimates 2021-22 of Ministry of Agriculture, Soybean production is estimated at 127.20 lakh tonnes as compared to 128.97 lakh tonnes in 2020-21.

2.1.2 Physico-chemical properties of Soy milk

Miller *et al.*, (2006) studied that about 8 ounces of unsweetened soy milk provide about 105 calories, 6 gms of protein, and 4 gms of fat per serving. It is a fantastic food with an abundance of nutrients naturally present, as well as an excellent source of vitamins, particularly vitamin B12 and vitamin D, and minerals like calcium and phosphorus.

Sunidhi *et al.*, (2021) reported that soy is a complete protein from plants since it contains all 10 essential amino acids.

Raja *et al.*, (2014) studied that soy milk has high in protein, vitamins, and minerals, also has roughly 3.5% of the same amount of protein as dairy based cow milk.

Kundu *et al.*, (2018) studied that the proximate composition of soy milk with ratio 1:3 (w/v) was reported as moisture 97.51 %, ash 0.43 %, fat 0.76 % and protein 1.27 %.

Sharma *et al.*, (2020) investigated that the soy milk has composition of 90.8 % moisture, 3.6 % protein, 2 % fat, 2.9 % carbohydrate and 0.5 % ash. The calcium content of soy milk is around 15 mg per 100 grams.

Paul *et al.*, (2020) estimated that fatty acid profile and studied its effects on CVD in very high concentrations, soy milk includes crucial mono- unsaturated and poly-unsaturated fatty acids, which are occasionally linked to cardiovascular health. Soya milk is a low-cost, hydrating, and nutritious beverage with a variety of biologically active ingredients that are in charge of its positive effects on the body.

Kang *et al.*, (2010) reported that Soy milk has a greater potential for health benefits because of the phytochemicals it contains, including phytic acid (1.0-2.2%), sterols (0.23-0.46%), and saponins (0.17-6.16%).

2.1.3 Physico-chemical properties of Coconut (*Cocos nucifera*)

Aminu (2010) studied that the level of zinc and iron found in the almond milk and showed that consuming it will significantly lower the prevalence of "hidden hunger" of people belongs to developing nations.

Patil and Benjakul (2018) studied that the commercial plant called the coconut palm (*Cocos nucifera*) is grown in tropical areas, primarily in Asia and revealed that the composition of a coconut fruit is shell, 9.8% water, and 51.7% kernel. Grated coconut meat kernel is frequently used to make coconut milk.

Sunil *et al.*, (2020) reported that mature coconut kernel having moisture, protein, fat, carbohydrate and ash content was 51 %, 2.41 %, 26.71 %, 32.62 %, 4.3 % respectively. The mineral such as potassium, sodium, calcium, iron, zinc ranged from 122.1 mg/100 g, 21.6 mg/100 g, 18.1 mg/100 g, 7.9 mg/100 g, 2.2 mg/100 g respectively. The energy value is reported as 253 kcal/100 g.

2.1.4 Physico-chemical properties of coconut milk

Seow and Geww (1997) studied that coconut milk contains a lot of vitamins and minerals, including zinc, iron, calcium, potassium, and magnesium. As well substantial amounts of vitamins C and E.

Adejuyitan *et al.*, (2014) concluded that coconut milk was high in calcium. While total saturated fat made up 10% of the total energy, milk was said to be high in vitamins and minerals. Coconut milk is utilised by the ice cream, confectionery, and bakery industries worldwide to improve the flavour and taste of numerous goods.

Fernando *et al.*, (2015) studied that like other milk substitutes that contain long-chain fatty acids, coconut contains medium-chain fatty acids (MCFAs), which the liver can readily digest and turn into ketone molecules that are beneficial for brain health and the treatment of memory disorders like Alzheimer's. In addition to MCFAs, the nutritional value of coconut is increased by the presence of soluble and insoluble fibre, which has a variety of antioxidant effects.

Khuenpet *et al.*, (2016) studied that coconut milk is an oil-in-water emulsion that is stabilised by naturally occurring emulsifiers like globulins, albumin, proteins, and phospholipids.

Sunidhi *et al.*, (2021) investigated that medium-chain triglycerides and minerals including copper, selenium, manganese, magnesium, and potassium are abundant in coconut milk. Unlike other plant-based milks, it contains a lot of fibre. For a wide range of culinary applications, including drinks, sauces, baking, and frying, coconut milk is readily available.

Ayah *et al.*, (2022) studied that coconut milk has a composition of crude protein 2.30 %, total fat 12.80 %, total carbohydrate 5.50 % and ash 0.18 %. He also revealed that mineral composition of coconut milk with respect to phosphorus, magnesium, potassium, calcium, sodium, iron, zinc, copper was 134 mg/100 g, 77 mg/10 g, 192 mg/100 g, 60.6 mg/100 g, 7.8 mg/100 g, 1 mg/100 g, 0.9 mg/100 g, 0.3 mg/100 g respectively.

2.1.5 Physico-chemical properties of Almond (*Prunus dulcis*)

Sang *et al.*, (2002) investigated that almond is the most widely consumed tree nut in the world and the leading producer of tree nuts, are members of the *rosaceae* family, which also includes apples, pears, prunes, and raspberries. They frequently serve as snacks and are used as ingredients in a range of processed foods, particularly in bakery and confectionery goods.

Sathe *et al.*, (2002) reported that with a composition of about 25%, almonds are a good source of proteins. AMP or amandin makes up the majority of the almond protein composition.

Gradziel (2011) studied that the *rosaceae* family includes drupes like the sweet almond (*Prunus dulcis*), of which the kernel or seed is the only edible component. The latter is made up of a skin that is also known as a testa surrounding an embryo (two cotyledons). A green, fleshy hull and a hard, pitted shell make up the pericarp, which houses the kernel.

Fernandez-Cuesta *et al.*, (2012) investigated that almonds are an excellent food source of lipids, which are primarily monounsaturated fatty acids, protein, dietary fibre, vitamins (including vitamin E), minerals, phenolic compounds, and phytosterols.

Gorji *et al.*, (2018) revealed that almonds are regarded as one of the brain foods since they support mental acuity, focus, recall abilities, memory, and sleep quality when consumed at night.

Kundu *et al.*, (2018) studied that almonds are a potent source of minerals and a noteworthy source of -tocopherol (36.4%). It also has a high fibre content (13.2%) in addition to being fortified with minerals like magnesium (19.5%), copper (16.0%), and phosphorus (13.4%). Almonds have a protein content of about 25%, with arginine levels that are particularly high. Almonds have a rather high fat content (49.4% of weight), but they stand out for having a particularly high level of MUFA (67%), which may be good for heart health.

2.1.6 Physico-chemical properties of almond milk

Burton and Ingold (1989) studied that almond milk contains alpha-tocopherol, which was the functionally active form of Vitamin E and a potent antioxidant that is essential for preventing the formation of free radicals.

Miller *et al.*, (2006) studied that magnesium, selenium, and vitamin E are all nutrients found in almond milk, which also has a nutty flavour. Typically, an 8-ounce glass of almond milk has 40 calories, 3.58 grammes of fat, and 1.51 grammes of protein.

Yetunde (2015) investigated that almond milk produced with water to bean ratio 1:3 having the moisture content of 86.11 ± 0.3 %, protein 1.70 ± 0.2 %, fat 3.40 ± 0.1 %, carbohydrate 4.50 ± 2 % and ash 3.04 ± 0.05 %. The energy value was in the range of 55.40 ± 45 kilo calories per 100 ml.

Kundu *et al.*, (2018) studied that proximate composition of almond milk. Protein content in almond milk was 1.308 % with amount of moisture content was noted at 72.04 % and fat content in almond milk observed to be 8.250 ± 0.100 .

Maria and Victoria (2018) investigated the proximate composition of the almond milk and reported that it contains 0.7 to 1.6% fat, 1.6 to 2.3% ash, 0.11 to 0.28% fibre, 0.33 to 2.77% carbohydrate, and 20.59 to 27.03 kcal/g energy value. The mineral content of the almond milk sample ranged from 8.62 to 20.00 mg/100g for calcium, 220.71 to 303.89 mg/100g for magnesium, and 104.07 to 165.85 mg/100g for phosphorus, respectively.

Sunidhi *et al.*, (2021) investigated that the heart-healthy omega-3 fatty acids and antioxidant vitamin E can both found in almond milk. It comes in a variety of flavours and has a low sugar content by nature.

2.2 Effects of processing treatments on nutritional properties of vegan beverage

2.2.1 Effect on soy milk

Papastoitsis and Wilson (1991) investigated that Bowman Birk Inhibitor (BBI), in particular, is digested by proteases K1 and B2 during seed germination, which lowers the concentration of protease inhibitors in general and BBI in particular.

Harjai and Singh (2007) studied that the lower value most likely results from the altered water-to-bean ratio chosen in the manufacturing of soy milk, but it may also be caused by the different cultivar of soybeans utilised.

Tripathi *et al.*, (2015) studied the soaking and simmering the soybean is advantageous in the presence of sodium bicarbonate at the time of grinding to inactivate the lipoxygenase and trypsin inhibitor activities. The greatest protein yield, which was 92–93% greater than that of other treatments, was achieved.

Murugkar (2015) studied that Soybean sprouting decreases phytic acid and trypsin inhibitor (TI), whose reduction would normally need extremely high heat (for TI) or techniques like ultrafiltration (for phytic acid). The use of sprouting as a pre-treatment produces superior quality because it is a natural, non-thermal, non-chemical procedure. Trypsin inhibitor levels in milk varied from 4.1 mg/g when soybeans were sprouted and heated to 121 °C to 2.0 mg/gm when soybeans were sprouted and heated to 100 °C, indicating that 75% of the target reductions in trypsin inhibitor were attained in later treatment.

Warle *et al.*, (2015) studied that germination of soybean effects drastically and decreases the carbohydrate content from 22.1-17.9 (%), starch from 12.23-10.21 (%), amylopectin from 6.2-4.4 (%), amount of ash content from 4.95-4.59 (%), fat from 24-10 (%), falling number 341 to 98 respectively. The oil absorption capacity also decreases from 3.45 to 3.26 (%). In contrast to other techniques, the hydroperoxide content was lower. With this approach, soymilk was produced with a hydroperoxide reduction of about 68%. According to the data, the percentages of moisture, protein, fat, ash, and carbohydrates were 91.51%, 3.19%, 2.36%, 0.49%, and 2.46%, respectively. The overall acceptability in the sense of organoleptic parameters with this method was good with bland taste and also removes beany flavour.

Niyibituronsa *et al.*, (2018) investigated that consumer preferred the soymilk made from soybean soaked with 0.05 % sodium bicarbonate solution prior to extraction. The protein and fat content were 2.3 ±0.7 %, 1.1 ±0.4 % respectively. Soybean treated with 5 % sodium bicarbonate prior to extraction of milk then protein and fat content were reported as 2.1 ±0.2 %, 1.5 ±0.2 % respectively.

Kaur and Kaur (2019) studied that upon germination, soybean seeds had 40.05–46.46% protein and increased levels of the amino acid such as lysine (5.70

mg/100 g), methionine (0.61 mg/100 g), and tryptophan (1.11 mg/100 g). There have been reports of large increases in the mineral such as potassium, calcium, magnesium, and phosphorus during germination. In vitro protein digestibility increased with germination, while antinutritional elements like trypsin inhibitor

2.2.2 Effects on almond milk

Taylor *et al.*, (2018) studied that whole soaked almonds had a greater phytate concentration (563 mg/100 g) and also focused on how to soak nuts to lower phytate levels and increase gastrointestinal tolerance. Phytate combines with minerals including calcium, iron, and zinc, preventing them from being absorbed and digested.

Ayder *et al.*, (2020) mentioned that the time required for blanching decreases since soaking in water causes the almond nut kernel to soften. Toxins are released into the water after soaking, and percent amylose content decreases. Higher yield is seen when they are submerged in water.

Seow and Gwee (1997) studied that the raw material such as almond nut is mixed with water and then ground in the wet milling process. The final product is influenced by the amount of additional water, milling temperature, pH, milling type, and feed rate.

Callweaert *et al.*, (2012) studied that the method begins with thermal processing or roasting to reduce the levels of benzaldehyde and pyrazine in almond milk to less than 0.5 ppm and to achieve a neutral taste.

Grundy *et al.*, (2016) studied that the wet grinding method involves removing the almond skins after the seeds have been soaked in water heated to between 85 to 100 °C for two to five minutes. Almond skin possesses antioxidant characteristics due to its abundance in flavonoids and other phenolic components. As a result, some of the nutritious benefits of the almond kernel are reduced when the skin is removed.

2.2.3 Effect on coconut milk

Arumughan *et al.*, (1993) analysed the microbial load of coconut milk and found that the initial microbial load is reduced, lipase is inactivated, and more bland-tasting milk is produced by blanching at 80 for 10 minutes.

Kwon *et al.*, (1996) demonstrated that coconut proteins are extremely heat-sensitive, when coconut milk was heated to 80 °C causes denaturation and coagulation of proteins.

Seow and Gwee (1997) reported that shelling and paring completely matured coconuts are the first labour-intensive steps in the extraction of coconut milk. Paring eliminates the brown testa, which gives extracted milk its brown colour and slightly bitter flavour

Seneviratne *et al.*, (2009) concluded that the brown coconut testa and white coconut kernel are the sources of the phenolic chemicals found in coconut milk. These phenolic compounds are thermally stable at cooking temperatures. Consequently, the phenolic compounds in coconut milk may retain their antioxidant capabilities while being cooked.

2.3 Effect of processing treatments on organoleptic properties of vegan beverage

Lokuruka (2011) studied that the sensory appeal and the visual appeal may be altered through processing and revealed that it effects on nutritional value of soybeans and soy products. Thermal processing at or below 100 °C for as long as necessary to reduce unwanted changes and advised to use brief intervals.

Sethi *et al.*, (2016) studied that cooked and soaked soybean in alkaline water have less beany flavour overall and good mouthfeel. With progression of time, several alterations have been applied to equipment used for heat treatment and various alternations in time and temperature.

Pascual-Albero *et al.*, (1998) studied that soaking and blanching of almond nut in water increases the moisture content of almond nut and ultimately product made from the respective almond. The obtained product has good sensory appeal.

Onsaard *et al.*, (2005) demonstrated that the proteins in coconut milk become denaturated and precipitate when exposed to high heat for an extended period of time. Coconut protein is more easily denaturated by heat in the acidic and basic pH ranges. The product made from coconut milk have great consumer acceptability

2.4 Storage study of vegan beverage

Onuorah *et al.*, (2001) Initial standard plate counts on sterilised samples stored at ambient and refrigerated temperatures were zero CFU/ml and 2.0721×10^4 CFU/ml, respectively, over the course of 180 days of storage. For sterilised samples stored at ambient temperature, the initial standard plate counts increased to 2.1989×10^4 CFU/ml over the course of 100 days of storage.

Khodke *et al.*, (2018) concluded that with longer storage time, there is gradual decrease in pH of soymilk. The initial pH of samples kept at room temperature as well as in the refrigerator was 6.95. The pH of a sterilised sample kept in a refrigerator dropped from 6.95 to 5.57 over the course of 180 days, while the pH of a sterilised sample kept at room temperature decreased from 6.95 to 5.70 over the course of 100 days.

Gandhi (2009) studied that the nutritional guidelines for soymilk and stated that 20,000 CFU/ml was the crucial level for SPC. In light of this SPC standard critical limit, the shelf life and consequent spoiling of soymilk were determined.

Hayes and Boor (2001) revealed that increased microbial load in soymilk may be a result of its vulnerability, since milk is the ideal environment for microbial development due to its availability of carbs, proteins, and fats, as well as its neutral pH. Staphylococcus, coliform, and other gram-negative bacteria may be among them.

Yadav *et al.*, (2016) studied the storage of beverages made with soymilk. they were discovered that beverages made with 50% mango juice kept well for 20 days. A five-day interval was used for the analysis of parameters including TSS, acidity, pH, viscosity, total solids, and overall acceptability. Standard pour plate method in nutritional agar was used to determine the presence of bacterial load.

Gamba *et al.*, (2020) studied the kefir made from cow milk and soy milk is microbially stable. A study revealed that kefir is a useful beverage that contains yeasts, lactic and acetic acid bacteria, and AAB. Free amino acids in the cow's milk and soy milk kefir after fermentation were $20.92 \text{ mg}/100 \text{ ml}^{-1}$ and $36.20 \text{ mg}/100 \text{ ml}^{-1}$, respectively.

Shukla *et al.*, (2017) also studied the microbiological parameter for the beverage sample stored in HDPE and glass bottles ranged from 1.02×10^4 to $4.45 \times$

10^4 cfu/ml for the control entire plate initially to the tenth day, and from 1.24×10^4 to 3.96×10^4 for the experimental beverage sample.

2.5 Energy value and Techno economic feasibility of vegan beverage

Kuchekar (2011) reported that the almond milk shake prepared from buffalo milk and almond (95 per cent buffalo milk and 05 per cent almond) T₁ was most accepted to the judges. The treatment T₁ was economical than rest of the treatments. Treatment T₁ scored the highest score by the panel of judges and rated between like very much to like extremely,

Jadhav *et al.*, (2003) reported that the cost of sapota milk shake varied from Rs. 17.57 to 20.82 per kg. Cost of production of treatment T₁ (incorporation of 10 per cent sapota pulp) was the lowest cost i.e., Rs. 17.57 as compared to treatment T₂ (incorporation of 20 per cent sapota pulp) and T₃ (incorporation of 30 per cent sapota pulp). The overall cost recorded for the different blends was comparatively lower than market prices of other types of milk shakes.

Narwade *et al.*, (2003) prepared kheer from safflower milk blended with buffalo milk. He concluded that the kheer prepared from 50:50 blend of buffalo milk and safflower milk could be recommended, as it was sensory acceptable and scored between 'like moderately' and 'like very much' and it costed Rs. 27.55 per kg, which is 20.72 per cent less than the conventional kheer

CHAPTER- III
MATERIAL AND METHODS

CHAPTER- III

MATERIAL AND METHODS

The present research entitled “**Studies on development and quality assessment of vegan beverage by using soy, coconut and almond milk**”, was carried out in Department of Food Engineering in the collaboration with Department of Food Processing Technology, Department of Food Chemistry and Nutrition, Niche area laboratory and the other Departments of College of Food Technology, Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani. Development of vegan beverage by using soy, coconut and almond milk with various trials and formulations done with substituting soymilk with coconut milk and almond milk was produced, optimized, and evaluated for the physico-chemical characteristics. The section below narrates the materials and methods followed for development and overall evaluation of the vegan beverage.

3.1 Materials

3.1.1 Raw material

Soybean (Var. *MAUS 71*), coconut and almond were obtained from local area of Parbhani region. Fructo-oligosaccharide syrup (*Foslife L-65*) and powdered jaggery was procured from food grade shop at Parbhani. The procured raw material was cleaned, extraneous material was removed, and further used for extraction soymilk, coconut milk and almond milk respectively.

3.1.2 Chemicals and Reagents

Most of the chemicals and standard reagents (analytical grade) used in this investigation were of analytical grade which were obtained from Department of Food Engineering, Department of Food Science and Technology and Department of Food Chemistry and Nutrition, College of Food Technology, Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani.

3.1.3 Processing and analytical equipments

The processing and analytical equipments included grinder, hot air oven, micro-Kjeldhal, soxhlet apparatus, muffle furnace, refractometer, pH meter and electronic weighing balance were used from Department of Food Engineering,

Department of Food Microbiology and Safety and, College of Food Technology, Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani.

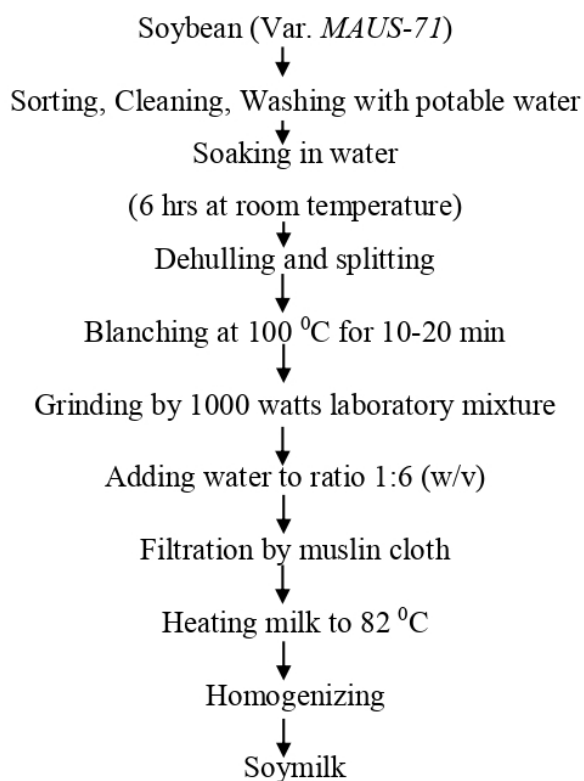
3.1.4 Packaging materials

The suitable packaging material i.e., Glass bottles and PET Bottles (250 ml) were procured from local market of Parbhani. Different types of packaging material were used to examine effect on the product and shelf life of the product over the time intervals.

3.2 Methods

3.2.1 Preparation of soymilk by 0.5 % Sodium bicarbonate method

Soymilk was extracted from soybean as per the method given by (Tripathi *et al*, 2015; Bansal and Kaur, 2014). Soymilk made by using 0.5 % sodium bicarbonate method following slight modifications were made for higher milk yield. The procured soybean was cleaned and soaked in potable water with 0.5 % NaHCO₃ for 6 hrs at room temperature. After that draining the water and dehulling, splitting of soaked soybean is necessary. Blanching is carried out to get soften and further grinding, filtration by muslin cloth and heating was performed to extract the soymilk.



Flow sheet No. 3.1. Preparation of soymilk by 0.5 % sodium bicarbonate method



(a) Soybean (var. *MAUS-71*)



(b) Almond



(c) 28 hr Germinated soybean



(d) Coconut



(e) FOS

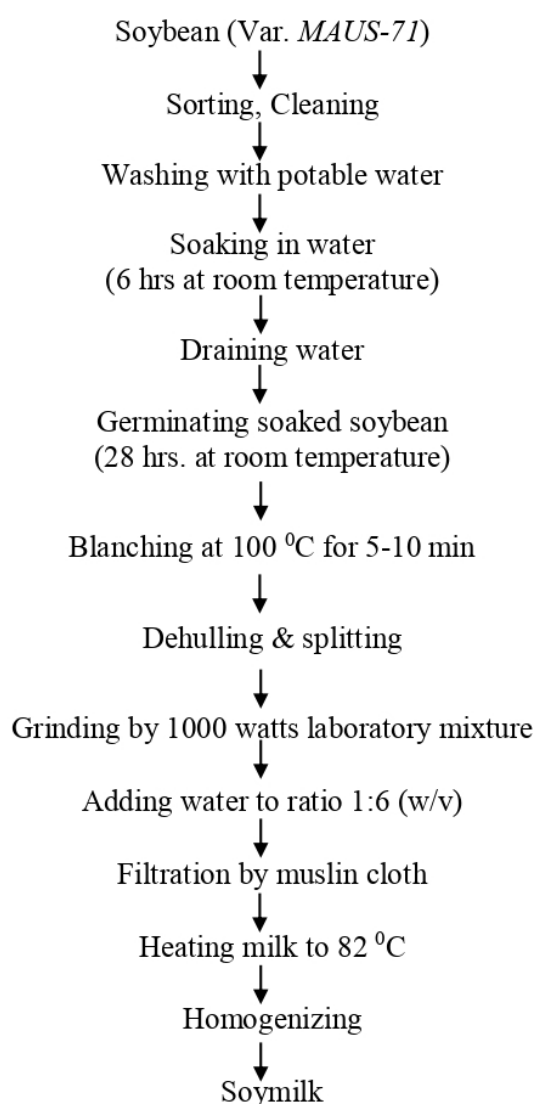


(f) Jaggery

Plate 3.1: Raw Materials

3.2.2 Preparation of soymilk by germination method:

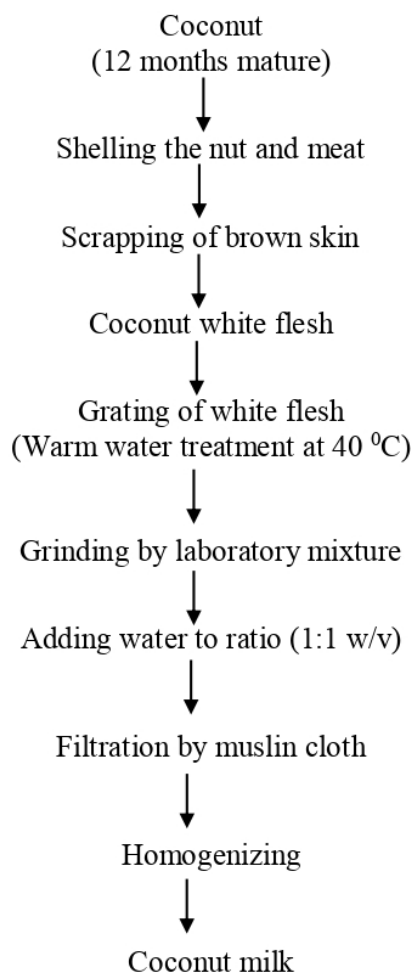
Soy milk was extracted from soybean as per the method given by (Kundu *et al*, 2018). Soy milk made by using germinated method following slight modifications were made for higher milk yield. The procured soybean was cleaned and soaked for 6 hrs at room temperature and germinated for 28 hrs followed by dehulling, splitting of germinated soybean. Blanching is carried out to get soften and further grinding, filtration by muslin cloth and heating was performed to extract the soymilk.



Flow sheet No. 3.2. Preparation of soymilk by germination method

3.2.2 Preparation of Coconut milk

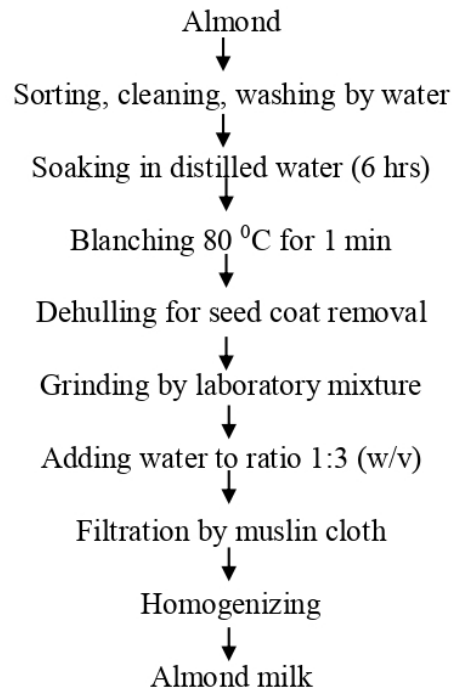
The coconut milk was extracted from mature coconut as per the method given by (Ayah *et al.*, 2022) following slight modifications were made for higher milk yield. The procured coconut was shelled, cleaned and soaked in warm distilled water followed by grinding and filtration was performed to extract the coconut milk.



Flow sheet No. 3.3. Preparation of coconut milk

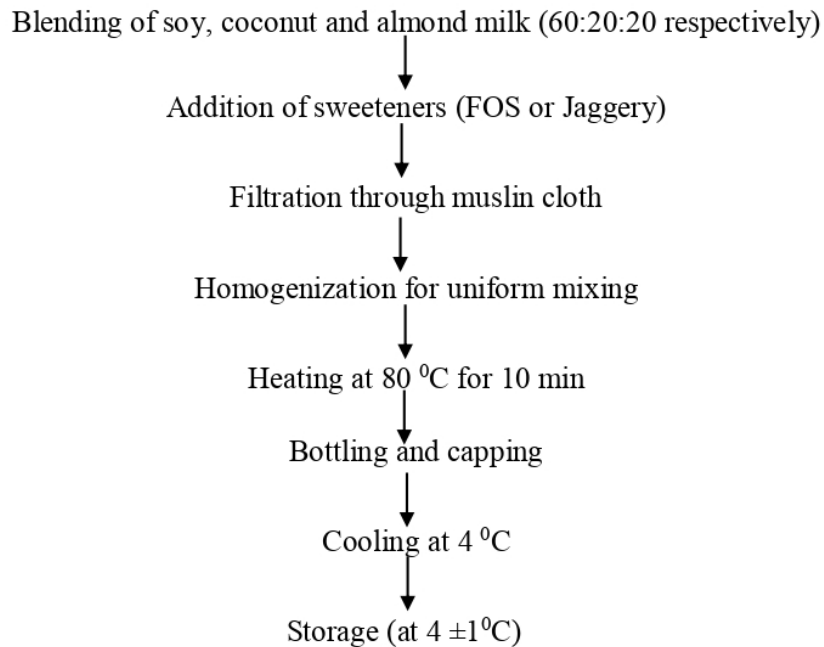
3.2.3 Preparation of almond milk

The almond milk was extracted from almond as per the method given by (Kundu *et al.*, 2018) following slight modifications were made for higher milk yield. The procured almond was cleaned and soaked overnight in distilled water followed by dehulling, splitting of almond and blanched to get soften and further grinding, filtration and heating was performed to extract the almond milk.



Flow sheet No. 3.4. Preparation of almond milk

3.2.4 Preparation of vegan beverage by using soy, coconut and almond milk



Flow sheet No. 3.5. Preparation of vegan beverage

3.3 Standardization of formulations of vegan beverage by using soy, coconut and almond milk.

Table 3.1 Formulations of vegan beverage

Run	Ingredients* (ml)			
	Soy milk	Almond milk	Coconut milk	Total
C₀	100	-	-	
A₁	80	10	10	100
A₂	70	15	15	
A₃	60	20	20	
B₁	80	10	10	
B₂	70	15	15	100
B₃	60	20	20	

Whereas,

C₀= (Control) 100% untreated soymilk (made by soaking for 6hrs at room temperature and grinding in lab. Mixture)

A subscript for soymilk with germination method;

A₁= 80% soymilk + 10% almond milk + 10% coconut milk

A₂= 70% soymilk + 15% almond milk + 15% coconut milk

A₃= 60% soymilk + 20% almond milk + 20% coconut milk

B subscript for soymilk with 0.5 % sodium bicarbonate method.

B₁= 80% soymilk + 10% almond milk + 10% coconut milk

B₂= 70% soymilk + 15% almond milk + 15% coconut milk

B₃= 60% soymilk + 20% almond milk + 20% coconut milk

3.4 Standardization of quantity of Sweeteners in selected vegan beverage

Table 3.2. denotes the different proportion of FOS and table 3.3. denotes the different proportion of jaggery for preparation of vegan beverage

Table 3.2. Optimization of FOS with selected A3 sample

Sample	Values*
	(gm/100ml)
	FOS
A₃F₁	6 gm
A₃F₂	12 gm
A₃F₃	18 gm

Whereas,

A₃F₁ = selected A3 sample + FOS 6 gm/100ml



(a) 28 hr Germinated Soybean milk



(b) Coconut milk



(c) Almond milk



(d) 0.5 % NaHCO₃ treated soybean milk

Plate 3.2: Extracted Milk Samples

A₃F₂ = selected A3 sample + FOS 12 gm/100ml

A₃F₃ = selected A3 sample + FOS18 gm/100ml

Table 3.3. Optimization of Jaggery with selected A3 sample

Sample	Values*
	(gm/100ml)
A₃J₁	4 gm
A₃J₂	8 gm
A₃J₃	12 gm

Where,

A₃J₁ = selected A3 sample + Jaggery 6 gm/100ml

A₃J₂ = selected A3 sample + Jaggery 12 gm/100ml

A₃J₃ = selected A3 sample + Jaggery 18 gm/100ml

3.5 Standardized recipe for the preparation of vegan beverage on the basis of sensory score per 100ml

Table below denotes the standardized recipe for preparation of vegan beverage **A₃F₂** and **A₃J₂**.

Table 3.4. Recipe for selected **A₃F₂ and **A₃J₂** samples**

Ingredients	A₃F₂	A₃J₂
Germinated Soymilk	60 ml	60 ml
Almond milk	20 ml	20 ml
Coconut milk	20 ml	20 ml
FOS	12 gm	-
Jaggery	-	8.0 gm

*Data represents mean ± standard deviation (n=3)

The data tabulated above illustrate the standardized recipe for the **A₃F₂** and **A₃J₂** vegan beverage per 100 ml. the recipe was developed by utilizing germinated soybean milk, almond milk and coconut milk, with the level as 60 ml, 20 ml and 20 ml respectively. The sweetener used for **A₃F₂** vegan beverage was 12 gm FOS and **A₃J₂** was made with 8 gm Jaggery. The blend of germinated soymilk, almond milk and coconut milk were done on the basis of organoleptic score of trained panels which was shown in table 4.9 and 4.10 (refer chapter, results and discussion).

3.6 Physico-chemical analysis of raw material and vegan beverage

3.6.1 Physical parameters of raw material

3.6.1.1 Length, width and thickness

Length, width and thickness of selected ingredients was measured using digital Vernier Caliper and obtained average results were expressed in millimeter.

Where, L= Length, W=Width, T=Thickness

3.6.1.2 Bulk density (ρ_b)

Bulk density calculated for the food grains, nuts and powders by dividing the mass of a quantity of grains to its volume, which was measured by using a constant volume cylinder and expressed as kg. m^{-3} .

$$\rho_b = M/V$$

whereas,

ρ_b = bulk density; M= weight on grain; V= volume of grain

3.6.1.3 True density (ρ_t)

True density of food grains, nuts and powders were measure by toluene displacement method. 10 g of sound sample were weighed on the digital weighing balance and filled into the measuring cylinder earlier filled with reference solution of kerosene or toluene. The increase in the level of liquid was measured after adding the grains. True density represented in kg. m^{-3} .

$$S = W/V$$

Whereas,

S= true specific gravity; W= grams of sample; V= average sample volume

3.6.1.4 Porosity

The porosity (%) of the bulk seed was defined as the fractions of the space in the bulk grain that is not occupied by the grain. The porosity of soybean seeds and almond nut was calculated using formula.

$$\text{Porosity (\%)} = \frac{\text{True density} - \text{bulk density}}{\text{Ture desnity}} \times 100$$



A_3F_2

**Vegan beverage with
fructoligosaccharide**



A_3J_2

**Vegan beverage with
jaggery**

**Plate 3.3: Optimization of sweeteners in
Vegan Beverage**

3.6.1.5 1000 kernel weight

Neat, clean, and sorted 1000 soybean seeds and almond nut were counted and further weighed by electronic balance. The average weight of 1000 seeds were calculated.

3.6.1.6 pH

pH value was measured with the help of digital pH meter. The sample for checking the pH was taken in a beaker and similarly, distilled water was taken in another beaker. The electrode of pH meter was dipped in distilled water until the pH was stabilized and then wiped gently. It was then dipped in the sample to be tested until the pH meter showed constant value. The pH value was hence recorded.

3.6.1.7 Titratable acidity

The acidity of sample was determined by process given as follows. Initially, 10 ml of sample was mixed with 100 ml distilled water. A measured aliquot (10 ml) was then titrated against 0.1N NaOH using phenolphthalein as indicator to a light pink colour. Acidity was expressed as per cent lactic acid (Ranganna, 1986).

$$\text{Titratable acidity (\%)} = \frac{\text{ml of 0.1 N NaOH} \times 0.009}{\text{Weight of sample}} \times 100$$

3.6.1.8 Specific gravity

The specific gravity of milk was determined according to the method followed by (IST, 1977).

Principle

The specific gravity of milk is the ratio between the weight of certain volume of milk at the standard temperature of 15.6 °C and the weight of the same volume of water at the same temperature. Since temperature influences specific gravity, it should be done at standard temperature.

Procedure

The sample of milk to be treated was thoroughly shaken and brought to a temperature between 10 °C to 21 °C. The milk was taken in the cylinder and lactometer was lowered into the milk without touching the walls of the cylinder. The lactometer reading was noted.

Calculation

$$\text{Specific gravity} = \frac{\text{C.L.R.}}{1000} + 1$$

Whereas, CLR= Corrected lactometer reading

3.6.1.9 TSS

The TSS of the sample was measured with the help of refractometer. The refractometer was cleaned with distilled water and wiped gently. The sample to be tested was taken with the help of dropper and just a few drops were put as layer on the glass of refractometer. Then the refractometer reading was seen by holding it against light and TSS was recorded in °Brix (Kuchekar, 2011)

3.6.1.10 Viscosity

Viscosity of vegan beverage was measured by using Brooke-Field Viscometer. LV model, spindle-61 of Viscometer. It is a versatile instrument for measuring the viscosity of Newtonian and non-Newtonian fluids. It is based on measurement of resistance to rotation of spindle immersed in the test material. The instrument can also be classed as Torsion Viscometer. Since the results are obtained by measuring torque on the rotary point of the instrument. The measurement of torque on a spindle with constant speed of rotation in test material is the basis of operation. The Brooke DV-E viscometer measures fluid viscosity at given shear rates. Viscosity is a measure of fluids resistance to flow. The principle of the DV-E is the rotate spindle (which is immersed in the test fluid) through a calibrated spring. The viscosity drag of the fluid against the spindle is measured by the spring deflection. Spring deflection is measured with a rotary transducer which provides a torque signal. The measurement range of DV-E (in centipoise OR mili Pascal seconds) is determined by the rotational speed of the spindle, the size and shape of the spindle is rotation and the full-scale torque of the calibrated spring. There are four basic spring torque series offered by Brooke field (Thakur. 2016)

3.7 Proximate composition of raw material and vegan beverage

3.7.1 Moisture (AOAC 2000)

The weight of empty crucible was taken and to which 10 ml of sample (soymilk, coconut milk, almond milk and vegan beverage) was added and weighed again. The crucible with sample was put in a hot air oven and dried at 105°C until



Plate 3.4: Digital pH meter



Plate 3.5: Viscometer

constant weight was obtained. After drying, the crucible was immediately put in desiccator for cooling so that moisture cannot be regained (Sharma, 2021). After it was cooled, the crucible was re-weighed to estimate the moisture content according to following formula:

$$\text{Moisture (\%)} = \frac{\text{Loss in weight (g)}}{\text{Weight of sample (g)}} \times 100$$

3.7.2 Protein (AOAC 2000)

The protein content of the sample milk and vegan beverage was determined by Macro Kjeldahl method which is based on the conversion of Nitrogen (N) into protein by multiplying the %N with 6.25 in case of legumes and 5.83-5.95 in case of cereals (Sharma, 2021)

Reagents:

- Digestion mixture – copper sulphate and potassium sulphate in ratio 1:9
- Concentrated sulphuric acid
- Sodium hydroxide (40%)
- Boric acid (4%)
- Mixed indicator – 0.1g methyl red and 0.5g bromocresol green dissolved in 100 ml of 95% ethanol
- Standardized 0.1N sulphuric acid

Procedure:

Two ml of sample was taken with the help of auto-pipette into the digestion tube. Five grams digestion mixture and approximately 25 ml sulphuric acid was added very carefully into the samples placed in digestion tubes. The tubes were then placed in Kjeldahl flask and digestion was carried out at 450°C for 2 hours until it turned clear bluish colour. This digestion process resulted in the conversion of nitrogen present in the samples into ammonium sulphate. The solution was cooled and distillation process was carried out the next day. Distilled water (30-40ml) was added carefully in to the digested solution and the tube was fitted to a condenser having 250 ml conical flask placed at the other end of the distillation chamber. Ten ml boric acid with a few drops of mixed indicator was added automatically in the conical flask. Next, 50 ml sodium hydroxide was added in to the digested solution either manually or automatically. This excess amount of alkali was added in order to neutralize the acid so that ammonia can be distilled

and trapped in boric acid solution as ammonium boric acid complex. The distillation process was run for 9 minutes till distillate became double. The next and final step was titration for which 0.1N standardized sulphuric acid solution was taken in burette. The distillate was titrated against 0.1N sulphuric acid until pink end point was observed. Blank was also run with an equal quantity of distilled water and the titration volume was subtracted from the sample values.

3.7.3 Fat (BIS 1981)

The fat content in the milk sample and vegan beverage were determined using Gerber's Butyrometer method which is based on digesting the organic matter like protein with strong acid and separation of fat by centrifugation with addition of alcohol (Kumari, 2020).

Apparatus:

- Ten ml automatic tilt device for sulphuric acid
- One ml automatic tilt device for amyl alcohol
- Pipette for measuring sample (10.75 ml)
- Butyrometer tubes
- Gerber's Centrifuge machine

Reagents:

- Concentrated sulphuric acid (90%), Purified amyl alcohol

Procedure:

All the milk samples and prepared vegan beverage enclosed in a sample box were heated in hot water to a temperature more than 37°C since fat melts at this temperature. The temperature was checked time and again with the help of thermometer to facilitate separation of fat in the next steps. In each butyrometer tube, 10 ml sulphuric acid was transferred with the help of tilt measure. Sample was taken into the 10.75 ml pipette and transferred to the butyrometer tube to which 1 ml amyl alcohol was added subsequently. The whole process was to be done with quickness such that the temperature did not fall. The stopper was fixed on the neck of butyrometer tube to close it firmly. The tube was shaken properly so that the contents of the tube were mixed thoroughly. Immediately the tubes were fitted in Gerber's centrifuge machine and centrifuged for 5 minutes. The fat column was visibly separated and could be read easily and the readings were noted



Plate 3.6: Micro-Kjeldahl Unit



Plate 3.7: Gerber Centrifuge

3.7.4 Fibre (AOAC 2000)

Fibre content was determined after digesting all other organic matter by the action of acid and alkali treatment (Kumari, 2020).

Reagents:

- Sulphuric acid (1.25%),
- Sodium hydroxide (1.25%).

Procedure:

Five grams of dried sample was taken in 500 ml spoutless beaker to which 200 ml of dilute sulphuric acid was added. It was refluxed for 30 minutes and then filtered with the help of Buchner funnel. A muslin cloth was placed over funnel and contents of the beaker were filtered in filtration flask. The residue obtained was washed with water such that the acid was washed off; the residue was taken in another spoutless beaker to which 200 ml of dilute alkali sodium hydroxide was added and refluxed for 30 minutes. Filtration was done again through muslin cloth and the residue left was washed with water to remove traces of alkali. Then the residue was transferred to a pre-weighed crucible and dried at 100°C in hot air oven until constant weight was obtained. This dried residue was left with fibre and ash. Therefore, ashing was done in muffle furnace so that fibre was removed for which loss in weight after ashing was recorded to estimate fibre content.

$$\text{Fiber (\%)} = \frac{\text{Weight of residue} - \text{Weight of ash after ignition}}{\text{Weight of sample taken}} \times 100$$

3.7.5 Ash (AOAC 2000)

Ash content was determined by burning and ashing the sample in muffle furnace. Ten ml of each sample was taken in triplicates for charring. Empty crucibles were weighed, in each of which 10 ml sample was transferred. The crucibles with samples were placed on hot plate and charred until the sample turned black. Then they were placed in muffle furnace and the arrangement was noted down. The samples were ignited in furnace at 550°C for 4 hours. After cooling, the weight of crucibles with ash was taken so that the residue/ash content was determined by subtracting the weight of empty crucible.

$$\text{Ash (\%)} = \frac{\text{Weight of ash (g)}}{\text{Weight of sample (g)}} \times 100$$

3.7.6 Carbohydrates

Carbohydrate content of milk and vegan beverage sample were calculated by difference method (Kumari, 2020) as follows;

$$\text{Total Carbohydrates} = 100 - \% (\text{Moisture} + \text{crude fat} + \text{crude protein} + \text{Ash} + \text{Crude fiber})$$

3.8 Minerals (AOAC 1980)

Elements namely calcium, iron, magnesium, zinc, manganese and copper were estimated using atomic absorption spectrometry (AAS) method (Kumari, 2020).

Reagents: Diacid mixture: Nitric acid (AR) and Perchloric acid in the ratio 5:1

Procedure:

Five hundred milligrams of moisture free sample were taken in conical flask of 100 ml capacity. Twenty-five ml diacid mixture was added in the flask and it was kept overnight for slow digestion. On the next day, the flasks were kept on hot plate at 200°C till 1 ml colourless solution was left. After cooling, the contents in the flask were washed and filtered through Whatman No. 42 ashless filter paper in volumetric flasks of 50 ml capacity. The volume was made up to 50 ml with distilled water. Then it was transferred to decontaminated plastic storage bottles with lids and labelled carefully. For blank, 25 ml diacid mixture alone was taken and digested and the volume was made up to 50 ml. The digested samples were then analysed for their mineral composition by AAS technique.

3.9 Storage study

The storage study of prepared vegan beverage was noted for a period of 15 days by packing in suitable glass bottles and PET bottles. The impact of storage conditions was analyzed for changes in its pH, TSS, acidity and overall acceptability. The formation or growth of microbes, undesirable taste and smell dictates the unacceptable nature of the product (Khodke et al., 2014).

3.10 Microbial analysis

Microbial examination is the best and commonly following quality assessment procedure performed in food testing lab. The microbial study of



Plate 3.8: Atomic Absorption Spectrophotometer

products like health drink mix was carried out as per the protocol given in Indian Standard Institute (ISI) (1969). The result obtained were noted as colony forming unit per gram (cfu/g) for evaluation of total plate count, yeast and mould count and total coliform count (Khodke et al., 2014).

3.10.1 Determination of total plate count (TPC) of prepared products

For isolation of bacteria pour plate technique was used. The nutrient agar media was used for examination of bacteria by total plate count (Harrigan and Mccance ,1966). Sterilization of nutrient agar media was carried out at 15 psi for 15 min. The 5th dilution i.e., 10^{-2} , 10^{-3} , 10^{-4} , 10^{-5} and 10^{-6} was poured on nutrient agar medium. Entire procedure was performed in a strictly sterile area with the help of laminar air flow. Then plates were incubated at 37°C temperature for 48 hours and microbial colonies were counted on digital colony counter (Khodke et al., 2014).

$$\text{TPC (CFU/ml)} = \frac{\text{No.of colonies} \times \text{Dilution factor}}{\text{Volume of sample taken}} \times 100$$

3.10.2 Determination of coliform count of vegan beverage

Coliform count of prepared products was evaluated by using violet red bile agar solid plating medium. The dilution was prepared i.e., 10^{-2} , 10^{-3} , 10^{-4} , 10^{-5} and 10^{-6} and then 1 ml of diluted prepared product was plated in pour plate method on a violet red bile agar medium. The plates were incubated at $37 \pm 10^{\circ}\text{C}$ temperature for 18 to 24 hours and coliform count were counted by colony counter (Khodke et al., 2014).

3.11 Energy value

Theoretical energy value prepared vegan beverage was calculated as per method given by (Atwater and Wood 1986). The system is based on the heats of combustion of carbohydrate, protein and fat which are corrected for losses in different biological activities. The one gram of carbohydrate provides 4 Kcal energy, one gram of protein provide 4 Kcal energy and one gram of fat provides 9 Kcal energy (Swami, 2021).

$$\text{Physiological energy} = (\% \text{protein} \times 4) + (\% \text{ carbohydrate} \times 4) + (\% \text{fat} \times 9)$$

3.12 Techno-economic feasibility

The cost of production of prepared vegan beverage was calculated by taking into consideration the cost of raw materials, processing cost, and miscellaneous cost etc (Swami, 2021).

3.13 Sensory evaluation of prepared product

Sensory evaluation has been defined as a scientific method used to evoke, measure, analyzed and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing. Prepared vegan beverage was evaluated for sensory characteristics like color, flavor, taste, and overall acceptability by a panel of semi trained judges, comprised of postgraduate students and academic staff members of College of Food Technology, V.N.M.K.V., Parbhani. Samples were scored based on a nine-point hedonic scale. Judges were asked to rate the product on 9-point Hedonic scale with corresponding descriptive terms ranging from 9 to 1 as 'like extremely' to 'dislike extremely' (Meilgaard et al. 1999).

(Sensory score card is given in Appendix- I)

3.14 Statistical analysis

All processing equipment's and analysis of samples were taken in triplicate. The data obtained for various treatments was noted and statistically analyzed by *CRD* (complete randomized design) to find the level of significance as per the method given by (Panse and Sukhatme 1967). The analysis of variance showed at significance at $P < 0.05$ level. The standard error (SE_{\pm}) and critical difference (*CD*) at 5 percent level were mentioned where needed (Swami, 2021)

CHAPTER- IV
RESULT AND DISCUSSION

CHAPTER- IV

RESULTS AND DISCUSSION

The present investigation entitled “**Studies on development and quality assessment of vegan beverage by using soy, coconut and almond milk**” was carried out in Department of Food Engineering with collaboration of Department of Food Chemistry and Nutrition, College of Food Technology, Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani during academic year 2021-22.

Major intention of research project was to develop a convenient functional vegan beverage with good amount of nutritional, bioactive compounds and nutraceutical importance. Looking to the consumer trend towards veganism, the present research was carried out to utilize the plant-based ingredients viz., soy, coconut and almond to prepare a vegan beverage resembling nature and characteristics of animal milk along with improved nutritional and organoleptic qualities. The efforts have been under take to utilize pre-processed soybean (germinated and sodium bicarbonate treated) along with nuts like almond and coconut are used to increase the protein and also to imparts organoleptic attributes by reducing effect of beany flavour of soybean milk.

Veganism is a contemporary and expanding societal phenomenon, that has been lately growing in western developed countries, which is demonstrated by the steadily growing number of vegans and people following plant-based diets.

In the research project sincere efforts have been also undertaken not only to prepare vegan beverage but also to improve its nutritional and organoleptic profile by incorporation of FOS as a source of dietary fiber and its mineral profile by sucrose by using organic jaggery powder. FOS and jaggery have emerged as a key player in the functional food sector. To provide a better alternative to people having lactose intolerance and community which is shifting towards the veganism.

Hence the experimental findings of utilizing soybean and other nuts to form the blend of vegan beverage the results are scientifically discussed under following subheads;

- 4.1. Physical properties of raw material
- 4.2 Proximate composition of raw material
- 4.3 Mineral composition of raw material
- 4.4 Proximate composition of extracted milk
- 4.5 Mineral composition of extracted milk
- 4.6 Organoleptic evaluation of prepared formulations
- 4.7. Effect of processing treatments on proximate composition of prepared beverage
- 4.8. Effect of addition of FOS and Jaggery on organoleptic properties of selected A₃ sample
- 4.9. Proximate composition of selected A₃F₂ and A₃J₂ samples.
- 4.10. Mineral composition of selected A₃F₂ and A₃J₂ samples
- 4.11 Physico-chemical properties off selected A₂F₂ and A₂J₂ samples
- 4.12 Storage studies of vegan beverage at refrigerated temperature 4 ±1°C and room temperature 30 ±1°C.
- 4.13 Microbial analysis of selected vegan beverage sample
- 4.14 Energy value of A₃F₂ and A₃J₂ vegan beverage
- 4.15 Techno economic feasibility of A₃F₂ and A₃J₂ vegan beverage

4.1. Physical properties of raw material

Physical properties play an important role in designing the machinery and equipment during the harvesting, post harvesting, milling operations and food processing. These properties help in the operation like separation, sorting and transfer. Different physical properties such as length, width, thickness, bulk density, true density, thousand kernel weight, porosity and angle of repose for the raw soybean and almond were evaluated and the obtained data of results are summarised in Table 4.1.

Table 4.1: Physical properties of raw material

Parameter	Values* (mm)	
	Soybean	Almond
Length	6.55 ±0.04	2.300 ±0.12
Width	5.61 ±0.05	16.98 ±0.10
Thickness	4.18 ±0.06	12.44 ±0.08
True density (g/ml)	0.91 ±0.1	1.025 ± 0.99
Porosity (%)	1.09 ±0.01	38.32 ±1.00
1000 kernel weight (g)	123.9 ±2.8	940.0 ±3.00

*Data represents mean ± standard deviation (n=3)

The data from the table 4.1 reveals that the length, width and thickness of soybean (*MAUS-71*) grain are 6.55 ±0.04 mm, 5.61 ±0.05 mm, 4.18 ±0.06 mm respectively. Similar findings for the physical properties of soybean i. e., length, width, and thickness are reported to be in ranges of 6.55 to 6.73 mm, 5.56 to 5.64 mm and 4.53 to 4.63 mm by (Wandkar *et al.*, 2012). Other parameters such as true density, porosity and 1000 kernel weight were noted to be 0.91 ±0.1 g/ml, 1.09 ±0.01, 123.9 ±2.8 gm, respectively.

In case of almond nut physical properties such as length, width, and thickness are noted as 2.30 ±0.12 mm, 16.08 ±0.10 mm, 12.44 ±0.08 mm respectively. (Aydin 2003) reported the similar results for physical properties of almond nut i.e., length 25.49 ±0.12 mm, width 17.03 ±0.10 mm and thickness 12.12 ±0.08 mm. True density, porosity and 1000 kernel weight were noted to be 1.025 ± 0.99 (gm/ml), 38.32 ±1.00 %, 940 ±3.00 gm, respectively. Similar findings reported by (Aydin, 2003).

4.2 Proximate composition of raw material

The chemical parameters like moisture content, protein, fat, carbohydrate, fiber and ash content for raw soybean, almond and coconut were analysed and obtained results are represented in the table 4.2 as below.

Table 4.2: Proximate composition of raw material

Parameter	Values* (%)		
	Soybean	Almond	Coconut
Moisture	8.73 ±0.33	4.45 ±0.08	43.66 ± 0.40
Protein	34.58 ±0.48	20.40 ±0.74	4.00 ±0.36
Fat	19.53 ±0.72	55.21 ±0.54	34.66 ±0.57
Carbohydrate	27.32 ±0.49	4.81 ±0.07	13.73 ±0.25
Ash	3.98 ±0.16	2.95 ±0.05	1.43 ±0.11
Dietary fiber	5.21 ±0.92	12.16 ±0.40	3.43 ±0.40

*Data represents mean ± standard deviation (n=3)

The obtained result from the table 4.2 showed that the moisture content for the raw soybean, almond and coconut was 8.73 ±0.33, 4.45 ±0.08 and 43.66 ± 0.40 (%) respectively. Soybean contain higher protein 34.58 ±0.48 (%) whereas almond and coconut contains 20.40 ±0.74, 4.00 ±0.36 (%) respectively. The protein content of coconut was similar with (Belewu *et al.*, 2014) Fat content in almond 55.21 ±0.54 (%) and coconut 34.66 ±0.57 (%) which was higher in comparison with soybean i.e., 19.53 ± 0.72 (%). Dry almond was found to be low source of carbohydrate with 4.81 ±0.07 (%). Carbohydrate content in raw soybean was found to be 27.32 ±0.49 (%) and that of coconut was 13.73 ±0.25 (%).

The results of proximate composition of almond with respect to moisture, protein, fat and carbohydrate agree with the findings of (Kalitha *et al.*, 2018). Protein, Fat and Carbohydrate of soybean was found to be similar with the research findings of (Bawachkar, 2021). Dietary fiber content of soybean, almond and coconut was reported as 5.21 ±0.92, 12.16 ±0.40 and 3.43 ±0.40 (%) respectively. The most notable attributes of soybean seeds are their oil and protein contents; however, they are also a good source of dietary fibre and isoflavones (Araceli *et al.*, 2008). Almonds contain several compounds with remarkable functions in the human body. They are rich sources of carbohydrates mainly dietary fiber. (Barreca *et al.*, 2020). Mineral

content of ingredients is depended on the ash content and (%) as was observed in soybean, almond and coconut was 3.98 ± 0.16 , 12.16 ± 0.40 and 3.43 ± 0.40 (%) respectively. The value of proximate content of coconut agrees with the result obtained by (Couto *et al.*, 2005).

4.3 Mineral composition of raw material

Minerals are known as the micro components and plays a very important role in regulation of various body processes and acts as a structural component (Wang *et al.*, 2011). The minerals like calcium (Ca), magnesium (Mg), phosphorus (P), zinc (Zn), iron (Fe) and copper (Cu) were estimated and the results are presented in the Table 4.3.

Table 4.3: Mineral composition of raw material

Parameter	Values* (mg/100gm)		
	Soy	Almond	Coconut
Calcium	277.26 ± 0.50	260 ± 1.00	2.60 ± 0.10
Iron	18.23 ± 0.49	3.68 ± 0.20	1.04 ± 0.12
Potassium	1732 ± 1.00	709 ± 0.57	98.48 ± 0.15
Magnesium	206 ± 0.49	273 ± 0.70	10.63 ± 0.35
Zinc	4.43 ± 0.44	3.26 ± 0.15	1.70 ± 0.20
Sodium	2.93 ± 0.06	4.80 ± 0.26	14.3 ± 0.87

*Data represents mean \pm standard deviation (n=3)

The result obtained in table 4.3 was mineral content with respect to calcium, iron, potassium, magnesium, zinc and sodium 277.26 ± 0.50 , 18.23 ± 0.49 , 1732 ± 1.00 , 206 ± 0.49 , 4.43 ± 0.44 and 2.93 ± 0.06 (mg/100g) respectively for soybean. Mineral composition of soy was found to be similar with the results narrated by (Etiosa *et al.*, 2017 and Nti *et al.*, 2016). The result obtained was found to be, mineral content with respect to calcium, iron, potassium, magnesium, zinc and sodium 260 ± 1.00 , 3.68 ± 0.20 , 709 ± 0.57 , 25.63 ± 0.70 and 3.26 ± 0.15 and 4.80 ± 0.26 (mg/100g) respectively for almond. Mineral composition of soy was found to be similar with the results narrated by (Kumari S, 2018 and Kalita *et al.*, 2018).

The result obtained was found to be, mineral content with respect to calcium, iron, potassium, magnesium, zinc and sodium 2.60 ± 0.10 , 1.04 ± 0.12 , 98.48 ± 0.15 ,

10.63 ±0.35, 1.70 ±0.20, 14.3 ±0.87 (mg/100g) respectively for coconut flesh. Mineral composition of soy was found to be similar with the results narrated by (Wynn, 2017).

4.4 Proximate composition of extracted milk

The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content for the extracted milk samples were estimated and obtained results are summarised in the table 4.4 as given below,

Table 4.4: Proximate composition of extracted soy milk

Sample	Values* (%)					
	Moisture	Protein	Fat	Carbo- hydrate	Ash	Dietary fiber
SM-U	92.03 ±0.07	1.93 ±0.04	3.99 ±0.11	3.24 ±0.21	0.51 ±0.03	0.42 ±0.02
SM-S	91.41 ±0.44	2.03 ±0.05	2.48 ±0.16	2.48 ±0.43	0.63 ±0.02	0.54 ±0.03
SM-G	93.20 ±0.25	3.18 ±0.06	1.46 ±0.10	1.46 ±0.78	0.60 ±0.01	0.70 ±0.01
S.E. ±	0.172	0.047	0.075	0.128	0.013	0.015
CD at 5%	0.059	0.145	0.260	0.442	0.045	0.052

*Data represents mean ± standard deviation (n=3)

Whereas,

SM-U= Soy milk (untreated soybean)

SM-S= Soy milk (sodium bicarbonate method)

SM-G= Soymilk (germination method)

From table 4.4 the study revealed that the moisture content of the germinated soy milk was higher than soy milk made from 0.5 % sodium bicarbonate treatment and untreated soy milk i.e., 93.20 ±0.25, 91.41 ±0.44 and 92.03 ±0.07 % respectively. Protein content of the soy milk made from germination method found to be higher than untreated and sodium bicarbonate treated method i.e., 3.18 ±0.06, 92.03 ±0.07, 91.41 ±0.44 % respectively which was similar with the values obtained by Singh *et al.*, (2015). Whereas, fat content of soy milk made from untreated soybean and soybean with sodium bicarbonate treatment was found to higher than soy milk with germination method i.e., 3.99 ±0.11, 2.48 ±0.16, 1.46 ±0.10 % respectively. Which was similar with the values obtained by Bansal and Kaur (2014). Increase in the protein and decrease in the fat content is due to difference in methods for the

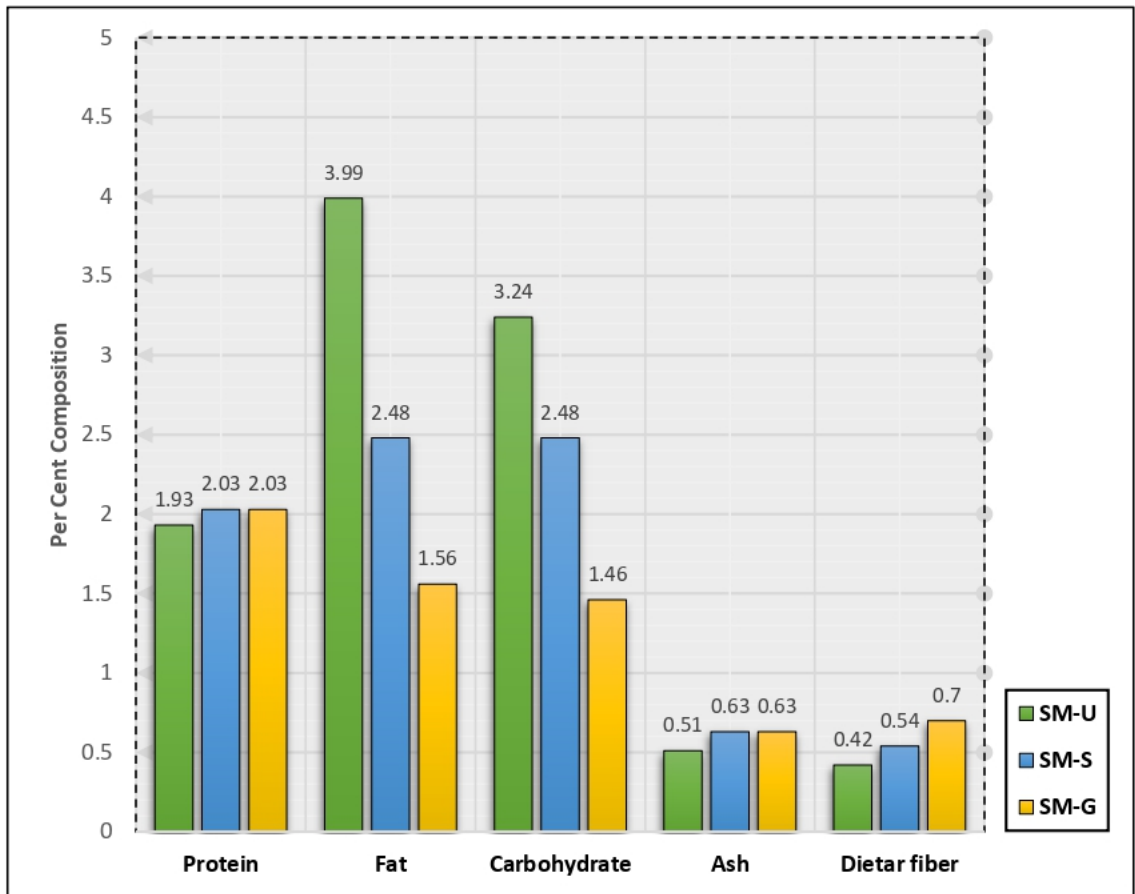


Fig. 4.1: Nutritional Composition of soybean milk by different methods

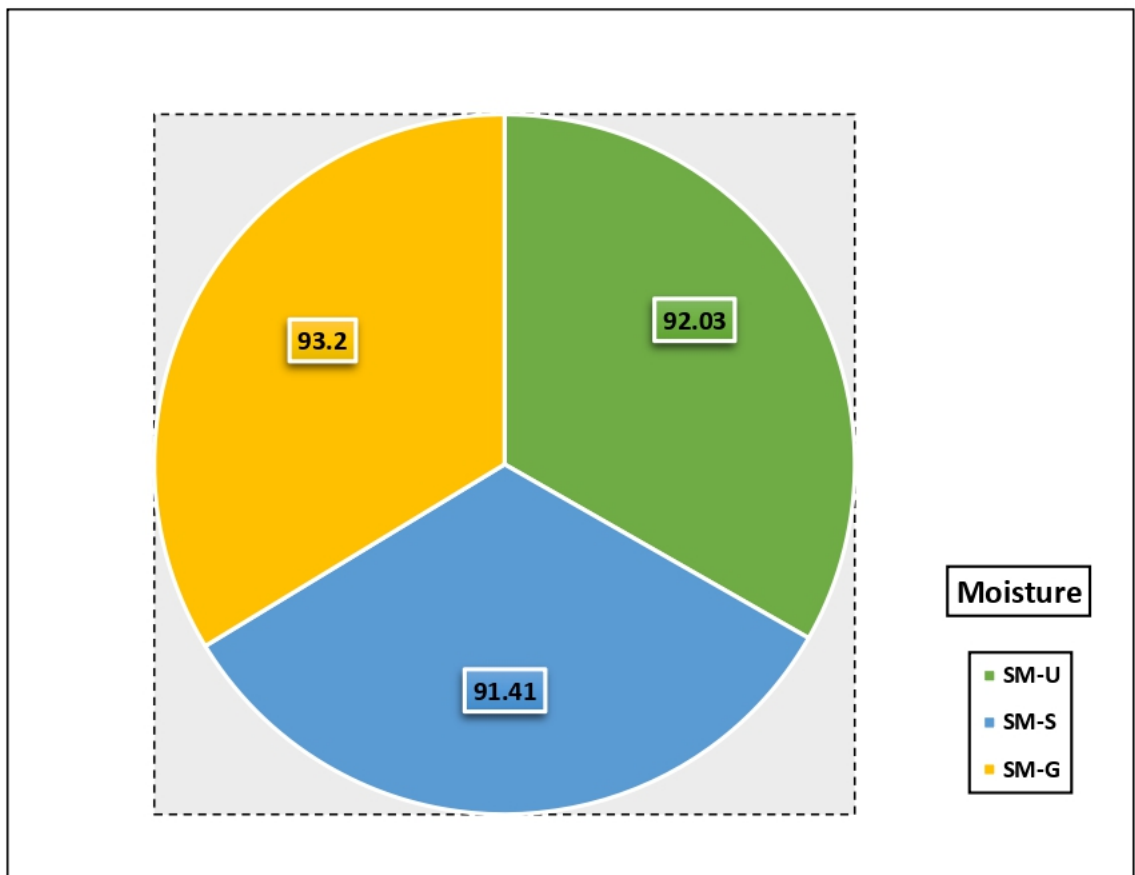


Fig. 4.2: Moisture composition of extracted milk

preparation of milk samples. Untreated soybean milk had higher carbohydrate content than soy milk with sodium bicarbonate method i.e., 3.24 ± 0.21 , 2.48 ± 0.23 % respectively. Germination method had lowest carbohydrate value i.e., 1.46 ± 0.22 . Bansal and Kaur, (2014) reported close findings.

Mineral content of ingredients is depended on the ash content and ash content of soy milk made from germination method, sodium bicarbonate method and untreated soybean milk was 0.60 ± 0.01 , 0.63 ± 0.02 , 0.51 ± 0.03 % respectively. According to Geetanjali *et al.*, (2010) ash content was drastically decreased in germinated soybean milk, possibly as a result of leaching into to the water, while a few essential minerals, which including Ca, Cu, and Zn, may have enhanced during the short germination period. Untreated soybean milk had lowest dietary fiber content than others i.e., 0.42 ± 0.02 %. Dietary fiber content of germinated soy milk and that of milk made with sodium bicarbonate method was 0.70 ± 0.01 , 0.54 ± 0.03 % respectively. Bansal and Kaur 2014 reported nearly similar findings. Extensive biochemical reactions take place during the process of soybean germination. Many of them lead to changes that are closely related to and can be key attributes in determining soy milk quality. Optimum germination time was selected, and soy milk made from 28 h-germinated soybeans under optimum germination conditions showed significantly higher protein content, a lower amount of carbohydrate and a generally comparable physicochemical profile to traditional soy milk

Statistical analysis *SEM* and *CD* at 5 % revealed that germination method was significant to produce soy milk in case of protein, fat, carbohydrate and at far w.r.t. moisture, ash and dietary fiber content (Kumari. 2020)

Table 4.5: Proximate composition of coconut and almond milk

Parameter	Values* (%)	
	Coconut milk	Almond milk
Moisture	75.36 ± 0.55	87.20 ± 0.97
Protein	1.91 ± 0.03	1.87 ± 0.10
Fat	19.44 ± 0.48	3.40 ± 0.10
Carbohydrate	2.50 ± 0.30	5.44 ± 0.18
Ash	0.52 ± 0.02	0.92 ± 0.05
Dietary fiber	0.63 ± 0.11	0.99 ± 0.14

*Data represents mean \pm standard deviation (n=3)

From table 4.5 it can be revealed that the moisture content of almond milk, coconut milk was 87.20 ± 0.97 , 75.36 ± 0.55 % respectively. The findings resembled with Alyaqoubi *et al.*, (2015), Dhankhar *et al.*, (2019), Alozie *et al.*, (2015). Protein content in the almond milk and coconut milk was found to be 1.87 ± 0.10 , 1.91 ± 0.03 % respectively. Alozie *et al.*, (2015) and Karunasiri *et al.*, (2020) reported similar findings. Coconut milk was higher in fat content i.e., 19.44 ± 0.48 % and that of almond milk was 3.40 ± 0.10 %. The present findings are in close conformity with the findings of Karunasiri *et al.*, (2020). Among the all extracted milk carbohydrate content of almond milk was 5.44 ± 0.18 % which was close with values obtained by Alozie *et al.*, (2015) and coconut milk was 2.50 ± 0.30 % respectively, which was close with vales obtained by Karunasiri *et al.*, (2020) and Dhankhar *et al.*, (2019).

Ash content of almond milk and coconut milk was 0.92 ± 0.05 , 0.52 ± 0.02 % respectively. Dietary fiber content of higher in almond milk samples i.e., 0.99. The dietary content of coconut milk was 0.63 ± 0.11 %. Values are in close conformity with findings of (Dhankhar *et al.*, 2019).

4.5 Mineral composition of extracted milk

Minerals are known as the micro components and plays a very important role in regulation of various body processes and acts as a structural component (Wang *et al.*, 2011). The minerals like calcium (Ca), magnesium (Mg), phosphorus (P), zinc (Zn), iron (Fe) and copper (Cu) were estimated and the results are presented in the Table 4.6.

Table 4.6 Mineral composition of extracted milk

Parameter	Values* (mg/100gm)		
	Soy milk (Germinated)	Almond milk	Coconut milk
Calcium	4.7 ± 0.89	13.3 ± 0.43	16.08 ± 1.0
Iron	1.06 ± 0.51	1.53 ± 0.19	0.57 ± 0.10
Potassium	51 ± 0.57	65.74 ± 0.36	36.96 ± 0.95
Magnesium	21.33 ± 1.07	41.85 ± 0.22	35.00 ± 0.07
Zinc	0.38 ± 0.23	4.65 ± 0.29	0.66 ± 0.9
Sodium	24 ± 0.57	6.30 ± 0.08	37.0 ± 1.0

*Data represents mean \pm standard deviation (n=3)

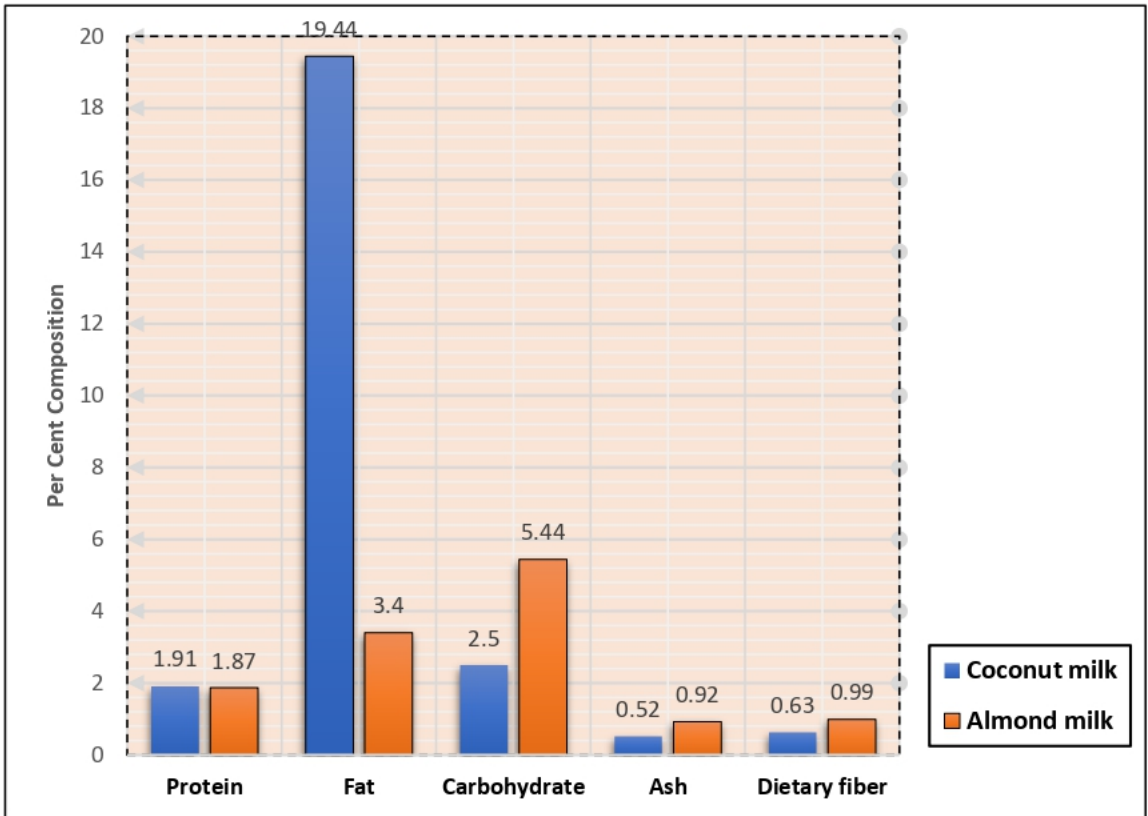


Fig. 4.3: Nutritional composition of almond and coconut milk

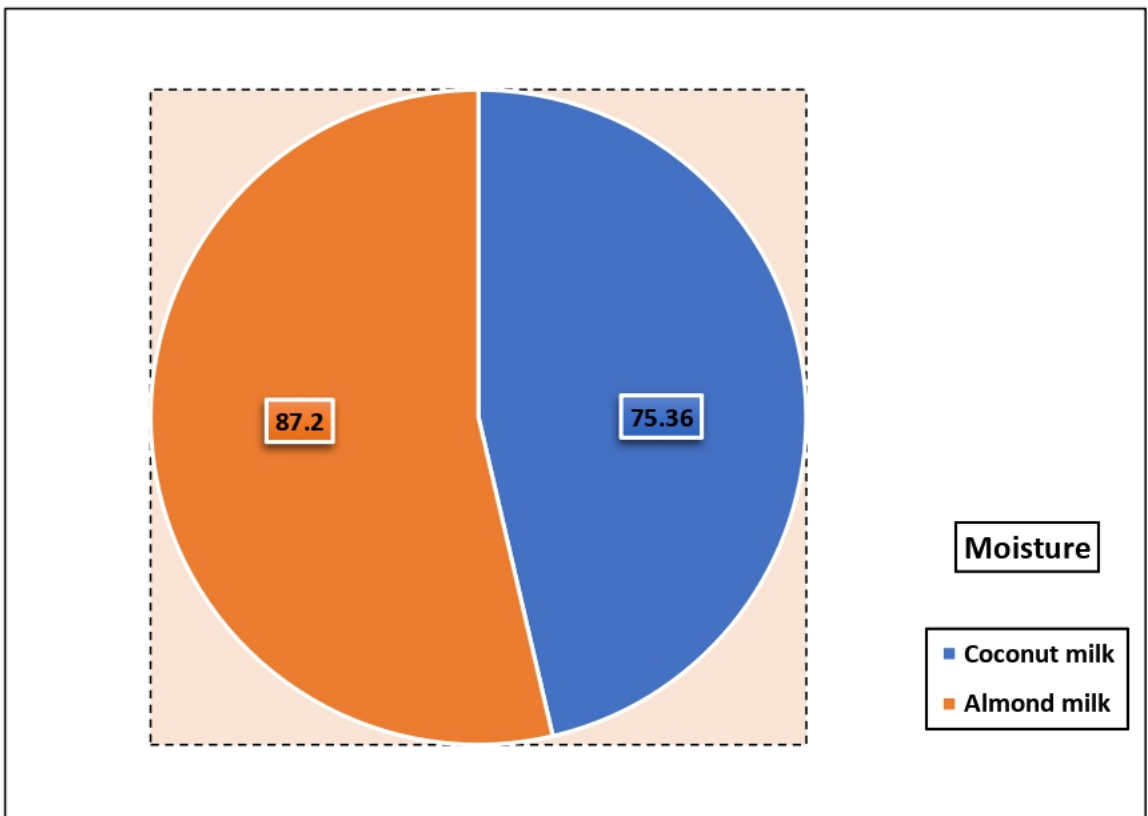


Fig. 4.4: Moisture composition of almond and coconut milk

The data in the table 4.6 revealed that the result obtained was found that mineral content with respect to calcium. Iron, potassium, magnesium, zinc and sodium was 4.7 ± 0.89 , 1.06 ± 0.51 , 51 ± 0.57 , 21.33 ± 1.07 , 0.38 ± 0.23 , 24 ± 0.57 (mg/100g) respectively for soy milk. Mineral composition of soy milk was found to be similar with the results narrated by Alozie *et al.*, (2015), Mazumder and Begum, (2016) and Scholz-Ahrens *et al.*, (2020).

The result obtained was found that mineral content with respect to calcium. Iron, potassium, magnesium, zinc and sodium was 13.3 ± 0.43 , 1.53 ± 0.19 , 65.74 ± 0.36 , 41.85 ± 0.22 , 4.65 ± 0.29 , 6.30 ± 0.08 (mg/100gm) respectively for almond milk sample. These results are in close conformity with the findings of Alozie *et al.*, (2015). The result obtained was found that mineral content with respect to calcium. Iron, potassium, magnesium, zinc and sodium was 177 ± 1.0 , 4.0 ± 0.10 , 638.96 ± 0.95 , 35.00 ± 0.07 , 0.66 ± 0.9 , 37.0 ± 1.0 (mg/100gm) respectively for coconut milk. Mineral composition was found to be resemble with Paul *et al.*, (2020).

The proportion of addition of almond milk and coconut milk was decided on the basis of their nutritional and mineral composition as well as organoleptic acceptability. The use of these nuts was attributed specially to reduce beany flavour effect due to lipoxygenase activity and simultaneously grab the health benefits with techno economically feasible product. The organoleptic evaluation of formulated samples from (table 3.1) presented in following table 4.7.

4.6 Organoleptic evaluation of prepared formulations

Organoleptic evaluation of vegan beverage samples carried out with the help of trained and semi trained panel members using the 9-point hedonic scale. The parameters like colour, sweetness, flavour, mouthfeel and overall acceptability was considered. The mean score of different organoleptic characteristics of different formulations from (table 3.1) made with germinated soy milk, coconut milk and almond milk summarised in the table 4.7

Table 4.7: Organoleptic evaluation of C₀, A₁, A₂, A₃ samples

Run	Organoleptic attributes*				
	Colour	Sweetness	Flavour	Mouthfeel	OAA
C ₀	7.0	7.0	6.6	6.3	6.5
A ₁	7.3	7.3	6.3	7.3	7.0
A ₂	7.6	7.6	7.3	8.0	7.5
A ₃	8.8	8.7	8.8	8.6	8.8
SE ±	0.166	0.204	0.235	0.204	0.117
CD at 5%	0.688	0.843	0.972	0.843	0.486

*Data represents mean ± standard deviation (n=3)

Whereas,

C₀= Control

A subscript for soy milk with germination method;

A₁= 80% soy milk + 10% almond milk + 10% coconut milk

A₂= 70% soy milk + 15% almond milk + 15% coconut milk

A₃= 60% soy milk + 20% almond milk + 20% coconut milk

The organoleptic attributes were scored based on 9-point hedonic scale ranges from 9 for like extremely to 1 for dislike extremely. The results obtained from the organoleptic score revealed that there was highest overall acceptability score 8.8 for the A₃ sample with compare to control. These results are in close conformity with the findings of Bansal and Kaur (2014). For the parameters like colour, flavour and texture sample A₃ showed the highest score. While sample A₁ showed the lowest score for all the parameters with overall acceptability score 6.5. Increasing the concentration of almond and coconut up to 20 % each was found to be acceptable by the consumers due to the flavour and mouthfeel of nuts. So, the acceptable limit of the soy milk, coconut milk and almond milk was found to be acceptable at 60%, 20%, 20% respectively.

The study also revealed that due to germination of soybean for milk extraction effects on prepared product in the sense of mouthfeel and lower beany flavour than other treatment. These results are in confirmation with findings of Jiang *et al.*, (2013). Incorporation of almond milk and coconut milk helped to enhance the colour and flavour attributes (Kuchekar, 2011)

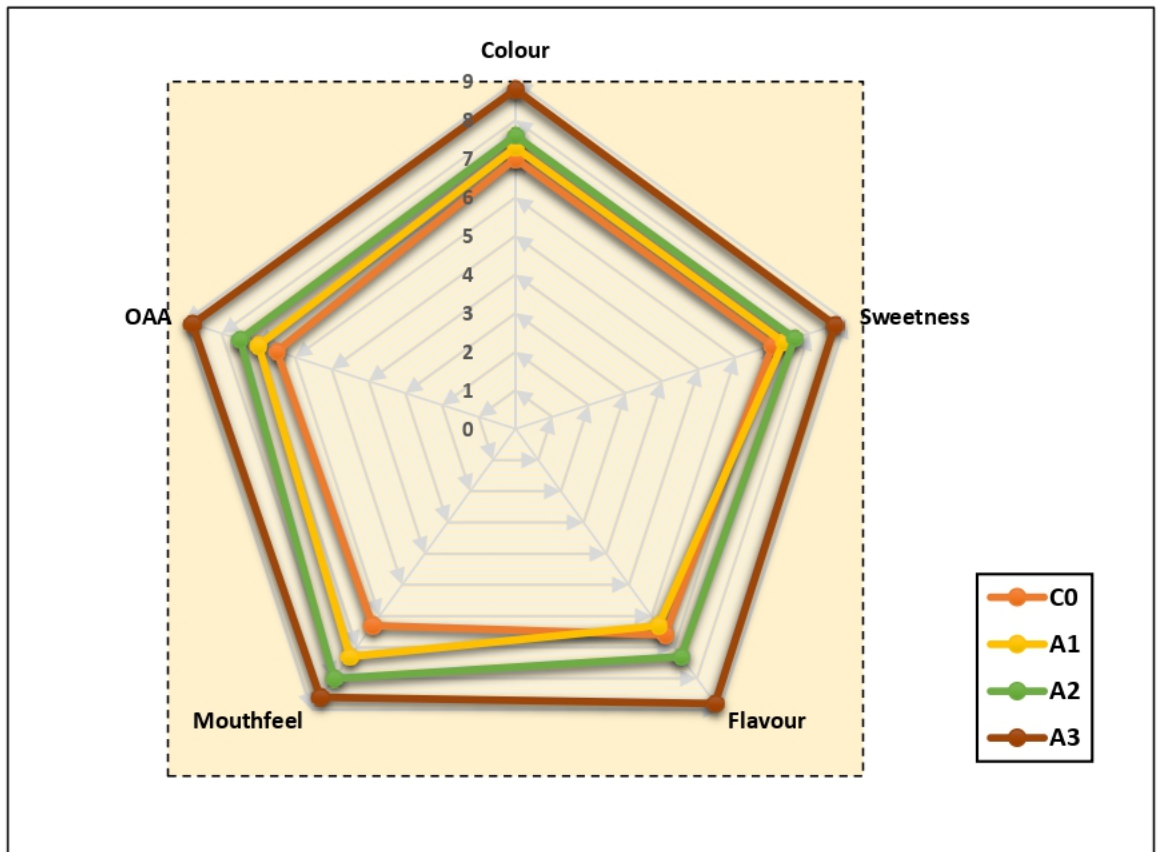


Fig. 4.5: Sensory evaluation of C_0 , A_1 , A_2 , A_3 samples

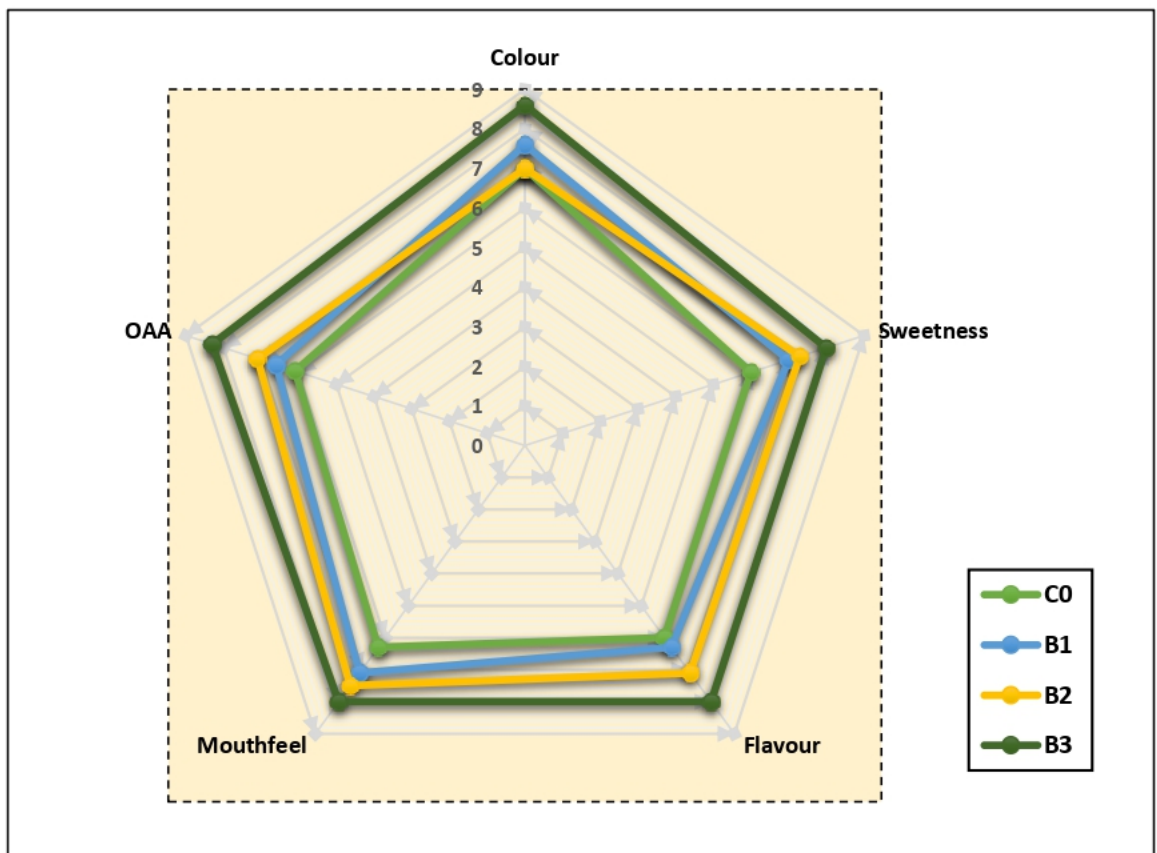


Fig. 4.6: Sensory evaluation C_0 , B_1 , B_2 , B_3 Samples

As per the statistical analysis CD at 5% the sample A₃ was found to be significant in every organoleptic attribute over the other three samples. Considering the above parameters, it was found that sample A₃ was having the highest score and superior than other samples hence it was selected for the further analysis with respect to its chemical composition (Kumari, 2020)

Table 4.8: Organoleptic evaluation of C₀, B₁, B₂, B₃ Samples

Ran	Organoleptic attributes*				
	Colour	Sweetness	Flavour	Mouthfeel	OAA
C ₀	7.0	6.0	6.0	6.3	6.1
B ₁	7.6	7.0	6.3	7.1	6.6
B ₂	7.0	7.3	7.1	7.5	7.1
B ₃	8.6	8.0	8.0	8.0	8.3
SE ±	0.166	0.117	0.166	0.131	0.186
CD at 5%	0.688	0.486	0.688	0.544	0.769

*Data represents mean ± standard deviation (n=3)

Whereas,

B subscript for soy milk with 0.5 % sodium bicarbonate method.

C₀= Control

B₁= 80% soy milk + 10% almond milk + 10% coconut milk

B₂= 70% soy milk + 15% almond milk + 15% coconut milk

B₃= 60% soy milk + 20% almond milk + 20% coconut milk

The results obtained from the organoleptic evaluation revealed in table 4.8. It was clear that there was highest overall acceptability score 8.3 for the B₃ with compare to C₀. For the parameters like colour, flavour and texture sample B₃ showed the highest score. While sample C₀ and B₁ showed the lowest score for all the parameters with overall acceptability score 6.1 and 6.6 respectively. These all parameters were similar with results reported by Bansal and Kaur (2014). Tripathi *et al.*, (2015) studied that 0.5 % sodium bicarbonate is effectively work to increase the color, flavor, mouthfeel and overall acceptability of soy milk beverage than the other methods in which heating is majorly followed. Increasing the concentration of almond and coconut up to 20 % each was found to be acceptable by the consumers due to the flavour and mouthfeel of nuts. Acceptable limit of the soy milk, almond milk and coconut milk was found to be acceptable at 60, 20, 20 (%) respectively. The study

also revealed that due to soaking of soybean in 0.5 % sodium bicarbonate solution for overnight effects on prepared product in the sense of mouthfeel and lower beany flavour at some extent but not as much lower germination treatment i.e. A₃ sample. Incorporation of almond milk and coconut milk helped to enhance the colour and flavour attributes.

As per the statistical analysis CD at 5% the sample B₃ was found to be significant in every organoleptic attribute over the C₀, B₁, B₂ samples. Considering the above findings, B₃ was selected for the further analysis to compare with A₃ with respect to its chemical composition to know difference between effect of sodium bicarbonate treatment and germination treatment (Kumari, 2020)

4.7. Effect of processing treatments on proximate composition of prepared beverage

Proximate composition helps to analyse the effect of processing treatments on nutritional content of the sample. Proximate composition of C₀ and A₃ and B₃ samples was carried out and parameters like moisture, protein, fat, carbohydrate, crude fiber and ash content were evaluated. Above formulations were selected on the basis of their organoleptic or sensory score. The overall acceptability of discussed sample is found to be good and these samples were selected for further analysis. The obtained results are presented in the table 4.9

Table 4.9: Proximate composition of A₃ and B₃ samples

Parameter	Values* (%)		
	C ₀	A ₃	B ₃
Moisture	92.03 ±0.07	88.43 ±0.98	89.00 ±0.4
Protein	1.93 ±0.04	3.20 ±0.04	2.98 ±0.03
Fat	3.99 ±0.21	5.49 ±0.03	5.90 ±0.08
Carbohydrate	3.24 ±0.21	2.05 ±0.04	2.41 ±0.11
Ash	0.51 ±0.03	0.79 ±0.09	0.68 ±0.02
Dietary fiber	0.42 ±0.02	0.73 ±0.01	0.63 ±0.05

*Data represents mean ± standard deviation (n=3)

Were,

A₃= Germinated soybean milk: coconut milk: almond milk (60:20:20)

B₃= Sodium bicarbonate treated soybean milk: coconut milk: almond milk (60:20:20)

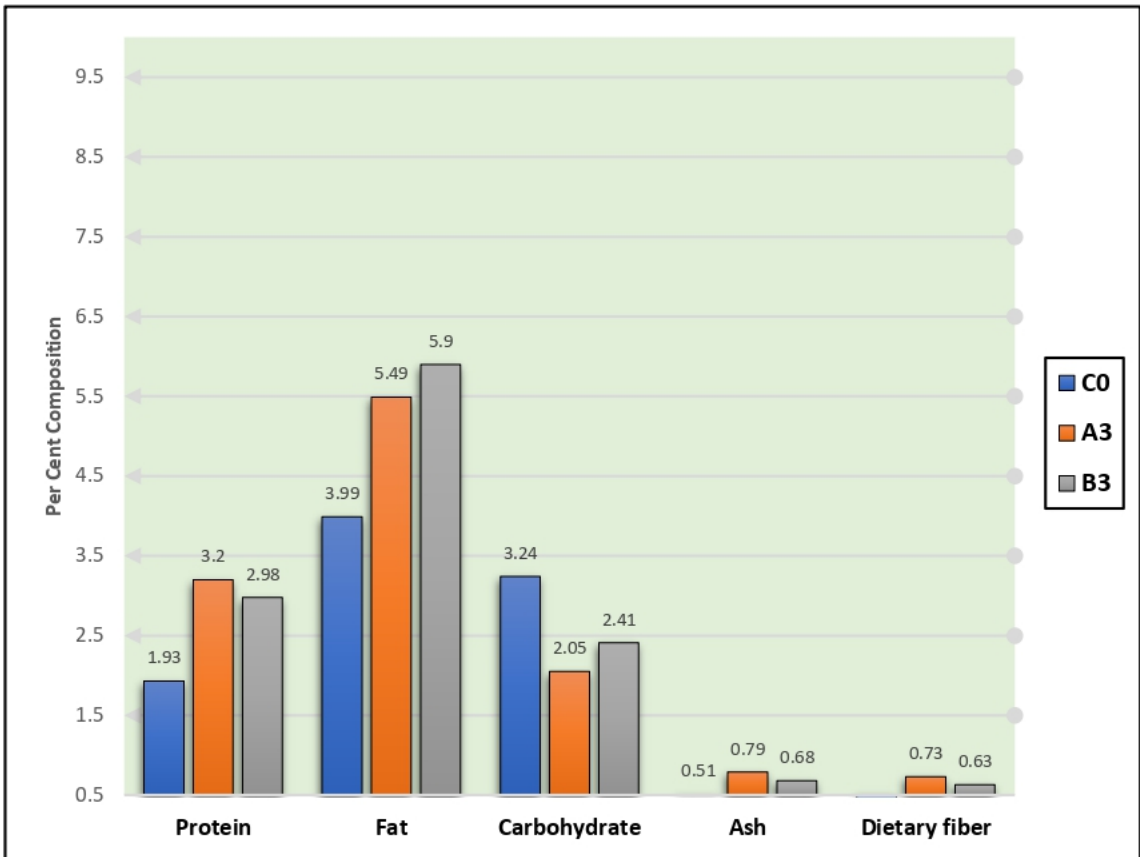


Fig. 4.7: Nutritional Composition of A₃ and B₃ vegan beverage

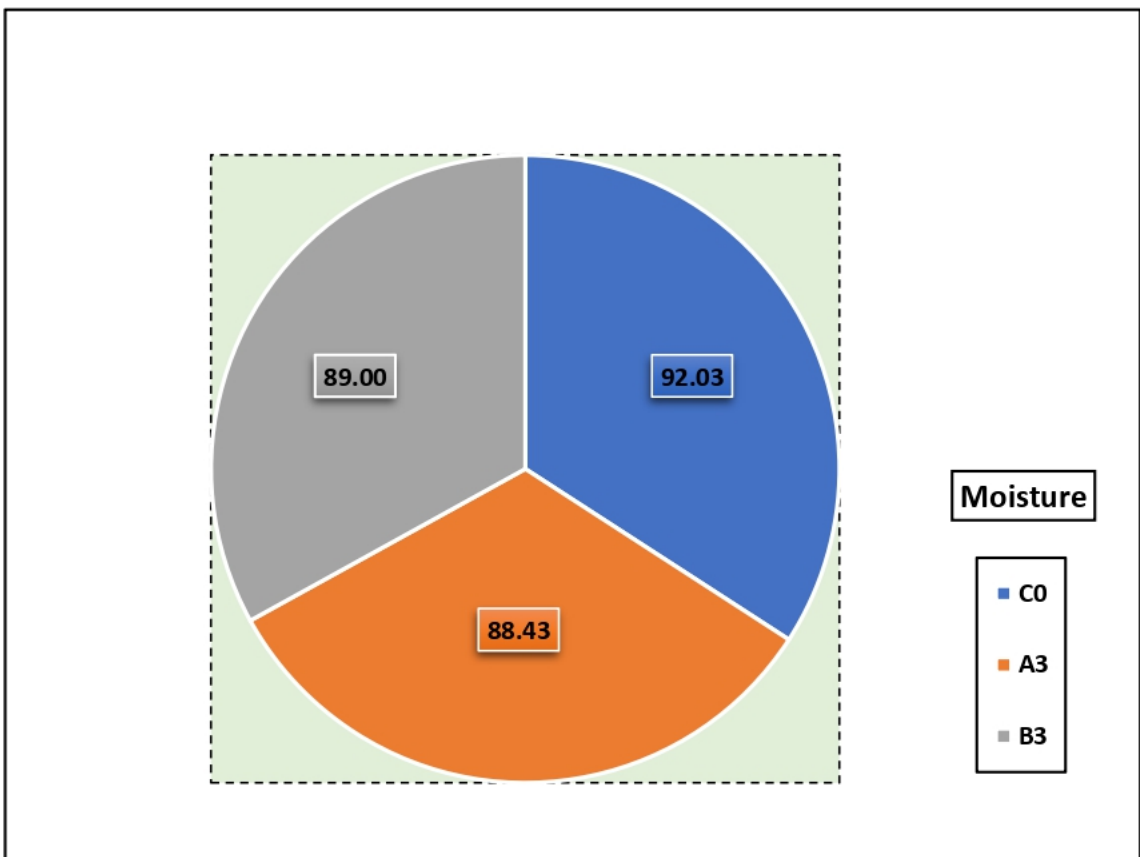


Fig. 4.8: Moisture Composition of A₃ and B₃ vegan beverage

Table 4.9 revealed that the all the samples come under the category of perishable food commodity as moisture content in control and C₀, A₃ and B₃ samples was 92.03 ±0.07, 88.43 ±0.98 and 89.00 ±0.4 % respectively, with compare to other two samples, the A₃ sample contains more protein and it was observed that A₃ sample contain 3.20 ±0.04 % protein and that of C₀ sample and B₃ sample was 1.93 ±0.04 and 2.98 ±0.03 respectively. Mostafa *et al.*, (1997) revealed that short time germination was also known to improve the protein quality in soybean as it promoted in vitro protein digestibility and generated a higher protein efficiency ratio. A₃ sample is made by using germinated soybean (Bansal and Kaur, 2014) reported that germination is effective to increase the protein content in soymilk and it also decreases the fat content of the same.

The fat content of C₀, A₃ and B₃ sample was 3.99 ±0.21, 5.49 ±0.03, 5.90 ±0.08 (%) respectively. The increased fat content in A₃ and B₃ was due to addition of high fat coconut and almond milk. C₀ sample contain more carbohydrate than other two samples. The carbohydrate content of C₀, A₃ and B₃ was 3.24 ±0.21, 2.05 ±0.04, 2.41 ±0.11 (%) respectively. The carbohydrate content of A₃ sample was lower than other samples. The loss of carbohydrate content in case of A₃ due to germinated soybean milk. Germination results decrease in simple sugars, low molecular weight oligosaccharides and starch which was quickly consumed in the metabolic process during germination (Mostafa *et al.*, 1997). The ash content of C₀, A₃ and B₃ sample was 0.51 ±0.03, 0.79 ±0.09 and 0.68 ±0.02 (%) respectively. The dietary fiber content of C₀ was lower than A₃ and B₃ i.e., 0.42 ±0.02, 0.73 ±0.01, 0.63 ±0.05 respectively.

Considering all the above factors and on the basis of chemical parameters such as protein, fat, carbohydrates, ash and dietary fiber as well as organoleptic properties such as mouthfeel, taste, colour, flavour and overall acceptability the selected sample A₃ vegan beverage sample was found to be statistically and scientifically significant over the all samples such as C₀, A₁, A₂, B₁, B₂, and B₃. Selected sample (A₃) have higher nutritional value and organoleptic values and accepted by committee members. The sample is prepared by using 60% soymilk which shows higher organoleptic and nutritional benefits. Hence (A₃) sample was selected for further research.

Sensory, rheological, and stability characteristics FOS are analogous to those of sucrose as compared to other fructans with higher levels of polymerization, such as inulin. A minimum of 5 g/day of intake is required, as per dose dependent studies on

FOS, for bifidogenic activity to be substantial. Reddy (2016) studied that FOS showed satisfactory tolerability up to dosage levels of 20 g/day, above which users may experience increased gas generation in the intestine, FOS does not have any after taste and has a masking effect and bulking effect on intense sweeteners. As a flavour enhancer, FOS masks off notes providing a well-rounded taste profile, FOS is also texture enhancer and also acts as a humectant, improving moisture retention and reducing syneresis. It helps extend shelf life by preventing the growth of unhealthy pathogenic bacteria, FOS is heat stable and stable at pH levels of greater than 4. It is very soluble in water and this makes it very convenient to be used in a variety of food applications. Jaggery is also known to be medicinal sugar because it has good mineral profile and it releases energy at very slow rate which helps consumer to get more healthy blood sugar level.

4.8. Effect of addition of FOS and Jaggery on organoleptic properties of selected A₃ sample

Formulations were made to prepare vegan beverage with two types of sweeteners. Among one of them fructooligosaccharide which is novel sweetener and jaggery powder which had been used since ancient times. Short fructose chains make up Fructooligosaccharide. They belong to the category of carbohydrates known as oligosaccharides. Fructooligosaccharide are barely sweet, low in calories, and have little impact on blood sugar levels.

Fructooligosaccharide is notable source of soluble dietary fiber. Fructooligosaccharide is low in calories, non-carcinogenic, and aids in the digestion of gluten as well as the reduction of cholesterol and fat levels as well as the activation of *Bifidus*.

Traditional Indian sweeteners like jaggery and khandsari are prepared from sugarcane in addition to sugar. In India, they are also referred as *Gur*. The term "*Medicinal sugar*" is frequently used to describe jaggery. It is used in pharmaceutical formulations, and regular jaggery consumption has been connected to a longer life expectancy for people. Mineral-rich jaggery has a slower rate of energy release, (Hipara *et al.*, 2020)

Different formulations from (table 3.2) were made using FOS in varying proportion and most acceptable proportion selected on the basis of organoleptic attributes.

Table 4.10: Organoleptic evaluation of A₃ sample with FOS

Sample	Organoleptic attributes*				
	Sweetness	Colour	Favour	Mouthfeel	OAA
A ₃ F ₁	7.4	7.9	7.6	7.7	7.5
A ₃ F ₂	8.6	8.8	9.0	9.1	8.9
A ₃ F ₃	7.6	7.8	7.5	7.4	7.4
SE ±	0.092	0.131	0.181	0.178	0.060
CD at 5%	0.130	0.456	0.628	0.617	0.210

*Data represents mean ± standard deviation (n=3)

Organoleptic evaluation of selected A₃ vegan beverage samples carried out with the help of trained and semi trained panel members using the 9-point hedonic scale. The mean score of different organoleptic characteristics of the A₃ vegan beverage summarised in the table 4.10. Sample A₃F₂ was obtained very much acceptable w.r.t. parameters like colour, sweetness, flavour, mouthfeel and OAA. The mean score for A₃F₂ was (8.9) and that of A₃F₁, A₃F₃ was 7.5 and 7.4 respectively. Bansal and Kaur (2014) reported similar findings.

Sample named A₃F₂ was statistically significant over other two samples w.r.t. like colour, sweetness, flavour, mouthfeel and OAA and selected for further studies.

Table 4.11: Organoleptic evaluation of A₃ sample with Jaggery

Sample	Organoleptic attributes*				
	Sweetness	Colour	Favour	Mouthfeel	OAA
A ₃ J ₁	7.1	7.7	7.4	7.3	7.4
A ₃ J ₂	8.7	8.6	8.93	9.0	8.9
A ₃ J ₃	7.5	7.5	7.53	7.8	7.7
SE ±	0.113	0.155	0.098	0.092	0.769
CD at 5%	0.393	0.536	0.339	0.319	0.266

*Data represents mean ± standard deviation (n=3)

Organoleptic evaluation of selected A₃ vegan beverage samples carried out with the help of trained and semi trained panel members using the 9-point hedonic scale. The mean score of different organoleptic characteristics of the A₃ vegan beverage summarised in the table 4.11. Sample A₃J₂ was obtained very much acceptable w.r.t. parameters like colour, sweetness, flavour, mouthfeel and OAA. (Tripathi et al., 2015) reported similar findings.

The mean score for A₃J₂ was (8.9) and that of A₃J₁ and A₃J₃ was 7.4 and 7.7. Sample named A₃J₂ was statistically significant over other two samples w.r.t. like colour, sweetness, flavour, mouthfeel and OAA and selected for further studies along with A₃J₂.

4.9. Proximate composition of selected A₃F₂ and A₃J₂ samples.

The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content for the A₃F₂ (FOS 12gm/100gm) and A₃J₂ (Jaggery 8gm/100gm) vegan beverage were estimated and obtained results are summarised in the table 4.12 as below.

Table 4.12: Proximate composition of A₃F₂ and A₃J₂ samples

Parameter	Values* (%)		
	C ₀	A ₃ F ₂	A ₃ J ₂
Moisture	92.03 ±0.07	80.44 ±0.92	79.91 ±0.81
Protein	1.93 ±0.04	2.81 ± 0.20	3.01±0.51
Fat	3.99 ±0.21	4.83 ±0.46	4.93 ±0.46
Carbohydrate	3.24 ±0.21	5.04 ±0.72	9.84 ±0.82
Ash	0.51 ±0.03	0.67 ±0.89	1.98 ±0.47
Dietary fiber	0.42 ±0.02	6.40 ±0.91	0.65 ±0.62

*Data represents mean ± standard deviation (n=3)

The data obtained from the table 4.12. revealed that the all the samples come under the category of perishable food commodity as moisture content in C₀, samples A₃F₂ was A₃J₂ was 92.03 ±0.07 and 80.44 ±0.92 and 79.91 ±0.81 % respectively. The increase in protein, carbohydrate, fat, and ash (minerals) content in A₃J₂ was due to jaggery Hirpara *et al.*, (2020). It was ranged from 3.01±0.51, 4.93 ±0.46, 9.84 ±0.82

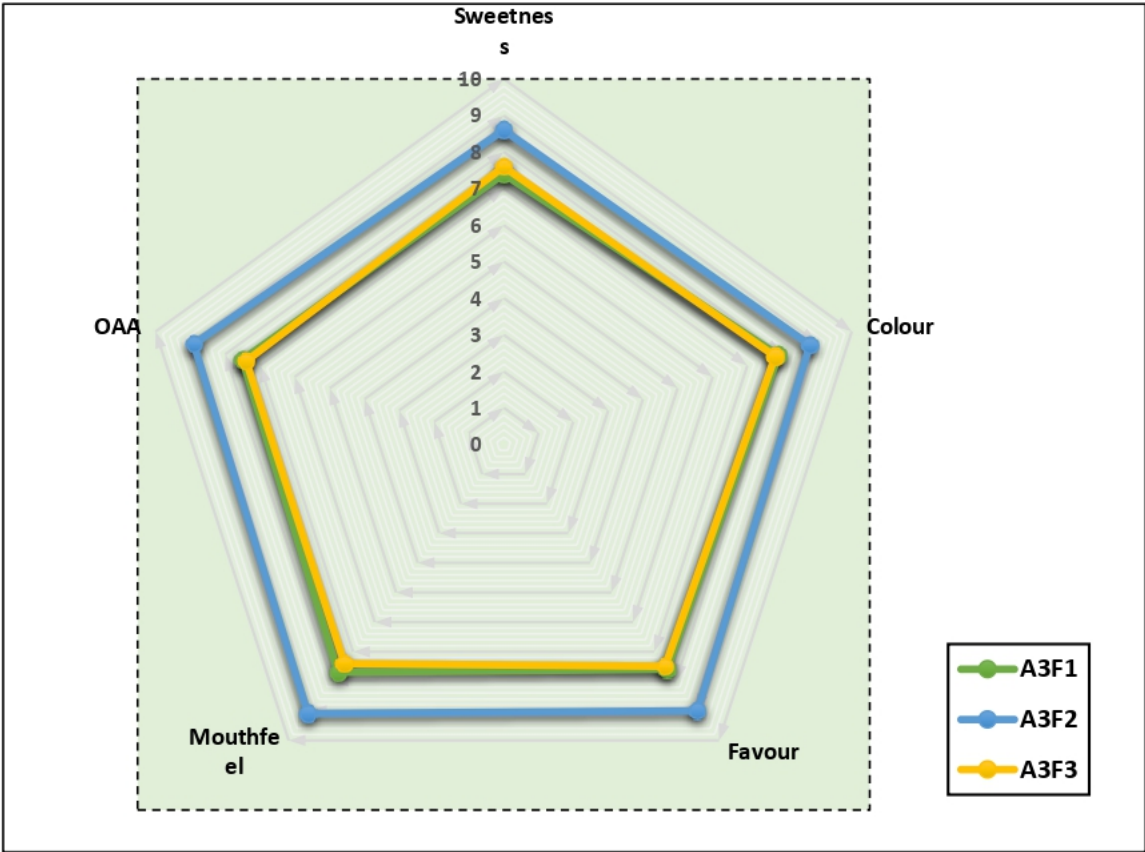


Fig 4.9: Sensory evaluation of A3 vegan beverage with FOS

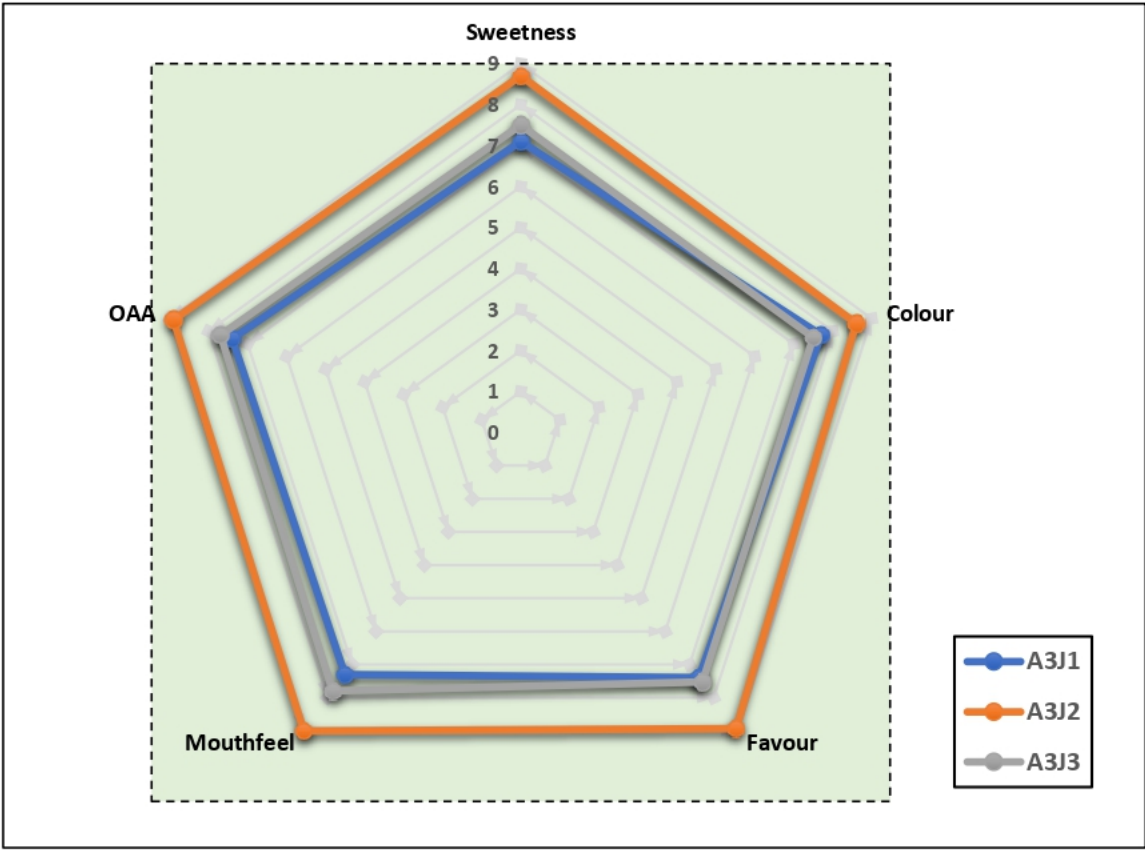


Fig. 4.10: Sensory evaluation of A3 vegan beverage with Jaggery

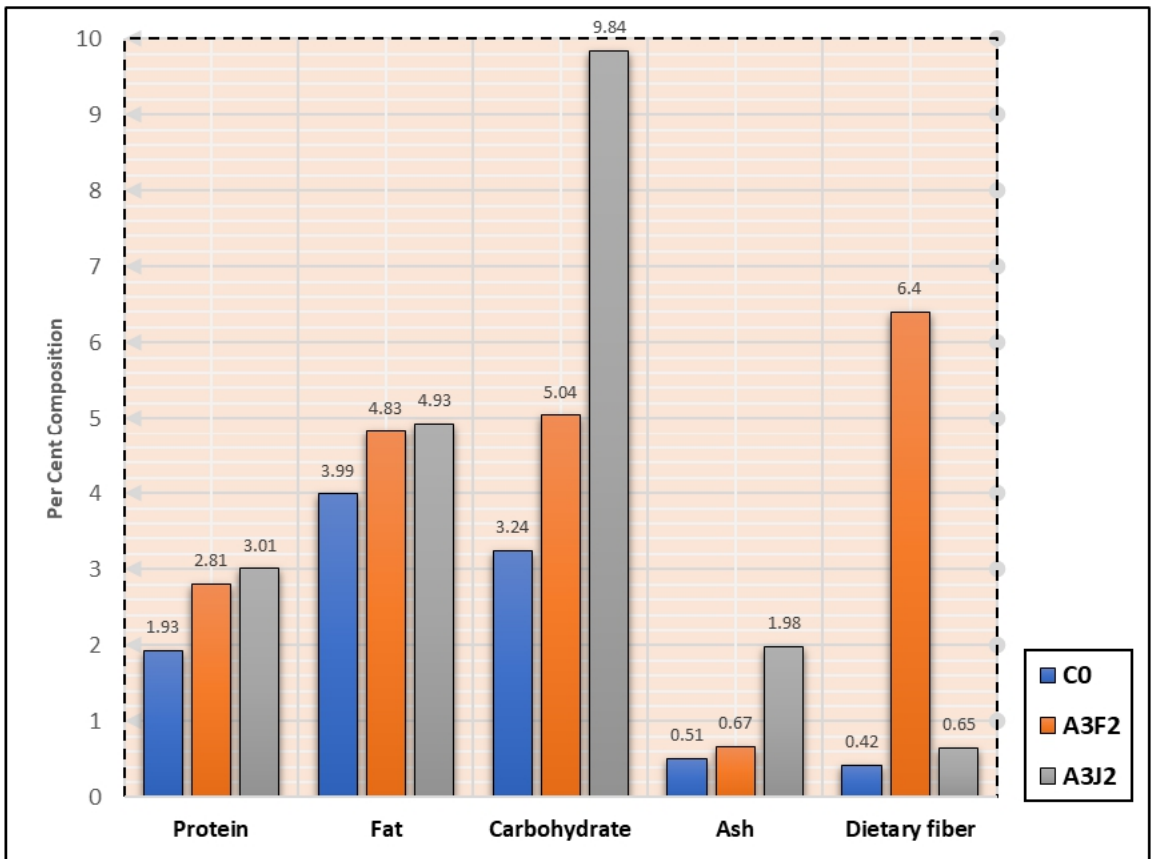


Fig. 4.11: Nutritional composition of A_3F_2 and A_3J_2 vegan beverage

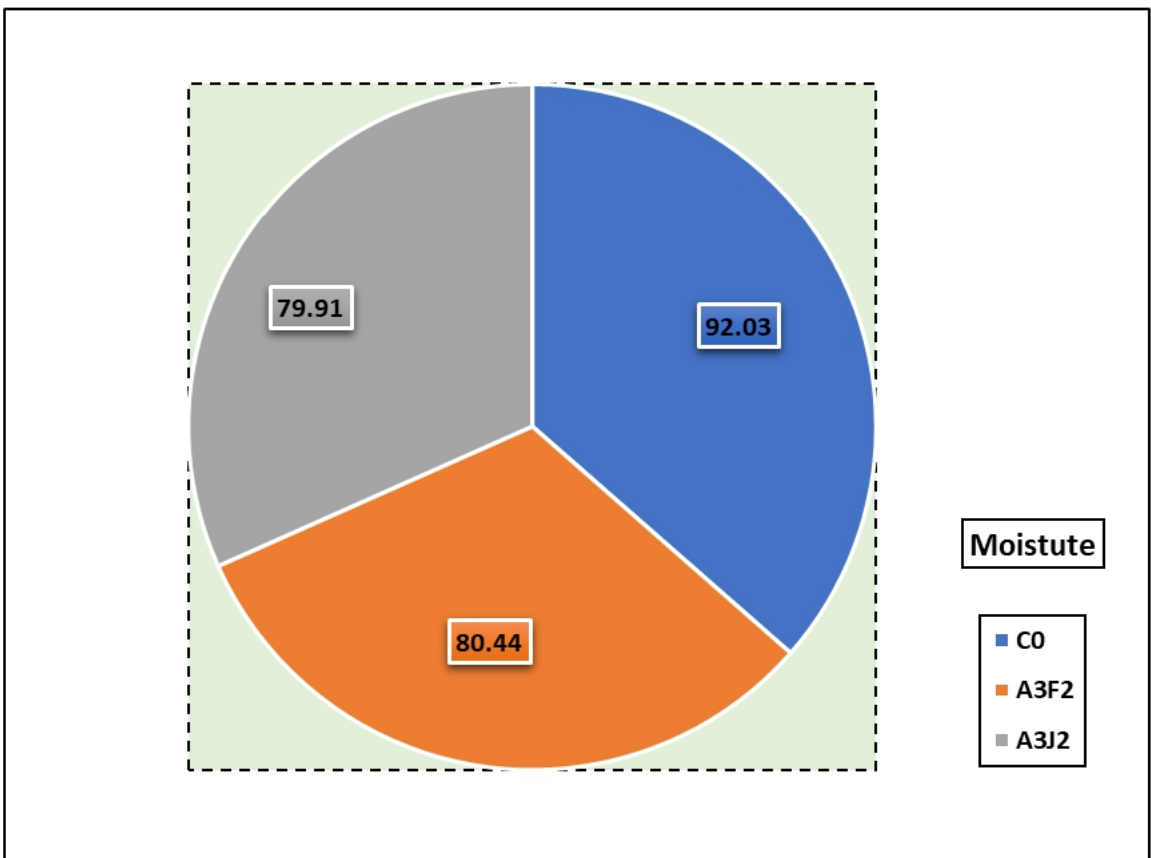


Fig. 4.12: Moisture composition of A_3F_2 and A_3J_2 vegan beverage

% respectively and that of A₃F₂ was ranged from 2.81 ± 0.20, 4.83 ±0.46 and 5.04 ±0.72, 0.67 ±0.89, % respectively.

FOS contain 75 % carbohydrate and among which 48.75 % composed of dietary fiber and remaining total sugars. Hence sudden increase in dietary fiber content in A₃F₂ vegan beverage sample was due to addition of FOS. Dietary fiber content of A₃F₂ sample was 6.40 ±0.91 and that of A₃J₂ was 0.65 ±0.62 %. Foslife-L65 (2022) and Bernet (2002) reported similar findings.

4.10. Mineral composition of selected A₃F₂ and A₃J₂ samples

The determination of mineral content of prepared product is essential to know the bioavailability of micro-nutrients to the body. The table 4.13. below depicts the mineral composition of A₃F₂ and A₃J₂.

Table 4.13. Mineral content of selected A₃F₂ and A₃J₂ samples

Parameter	Values* (mg/100gm)	
	A ₃ F ₂	A ₃ J ₂
Calcium	8.69 ±0.34	11.89 ±0.44
Iron	1.40 ±0.38	1.92 ±0.57
Potassium	51.13 ±0.26	53.53 ±0.91
Magnesium	28.16 ±0.56	33.76 ±0.34
Zinc	1.28 ±0.67	1.37 ±0.87
Sodium	23.06 ±0.45	24.74 ±0.68

*Data represents mean ± standard deviation (n=3)

The data obtained from the table 4.13. revealed that A₃J₂ had higher amount of mineral composition. The calcium, iron, potassium, magnesium, zinc and sodium content were A₃J₂ vegan beverage sample was 11.89 ±0.44, 1.92 ±0.57, 53.53 ±0.91, 33.76 ±0.34, 1.37 ±0.87 and 24.74 ±0.68 (mg/100 gm) respectively. Jaggery was dense in mineral content Hirpara *et al.*, (2020). The calcium, iron, potassium, magnesium, zinc and sodium content were A₃F₂ vegan beverage sample was 8.69 ±0.34, 10.40 ±0.38, 51.13 ±0.26, 28.16 ±0.56, 1.28 ±0.67 and 23.06 ±0.45 (mg/100 gm) respectively.

4.11 Physico-chemical properties of selected A₂F₂ and A₂J₂ samples

Physical and physico-chemical properties are essential in determining the quality attributes and shelf studies. The following table 4.14 depicts physico-chemical parameters of C₀, A₃F₂ and A₃J₂.

Table 4.14. Physico-chemical properties of A₃F₂ and A₃J₂ samples

Parameter	Samples*		
	C ₀	A ₃ F ₂	A ₃ J ₂
pH	6.70 ±0.17	6.90 ±0.02	7.0 ±0.07
Acidity (%)	0.22 ±0.01	0.13 ±0.01	0.24 ±0.01
Density (gm/cm ³)	1.019	1.051	1.037
Specific gravity	1.015	1.055	1.031
Total solids	8.66	13.78	11.33
Viscosity	7.8	8.3	8.1

*Data represents mean ± standard deviation (n=3)

Table 4.14 reveals that the pH of C₀ sample A₃F₂ and A₃J₂ sample was found 6.70 ±0.17, 6.90 ±0.02 and 6.90 ±0.02 respectively. The acidity (%) of A₃J₂ was higher than the other samples i.e., 0.24 ±0.01 %. The (%) acidity of C₀ and A₃F₂ was 0.22 ±0.01, 0.13 ±0.01 (%) respectively. Specific gravity of all the milk samples was higher than the water and i.e., for C₀, A₃F₂, A₃J₂ was 1.015, 1.055, 1.031 respectively. The density of control sample, A₃F₂ sample and A₃J₂ samples was 1.019, 1.051, 1.037 (gm/cm³) respectively. Khodke *et al.*, (2014) reported similar findings.

4.12 Storage studies of vegan beverage at refrigerated temperature 4 ±1°C and room temperature 30 ±1°C.

The storage studies for the selected vegan beverage sample i.e., A₃F₂ and A₃J₂ was performed at room temperature i.e., 30 °C and refrigerated temperature 4 °C. The analysis of parameter such as pH, titrable acidity, TSS was determined by the periodic time interval of 15 days. The results are elaborated in the table 4.15 and table 4.16 as given below.

Table 4.15 Storage study of A₃F₂ at room temperature 37 ±1°C.

Parameter	pH		Titrable acidity (%)		TSS	
	PET Bottle	Glass Bottle	PET Bottle	Glass Bottle	PET Bottle	Glass Bottle
0 th	6.91	6.91	0.13	0.13	12.34	12.34
3 th	6.72	6.82	0.19	0.17	12.28	12.31
6 th	6.46	6.74	0.23	0.21	12.00	12.86
9 th	5.15	6.27	0.27	0.25	11.55	11.98
12 th	5.58	6.14	0.28	0.26	10.20	10.89
15 th	5.73	6.01	0.30	0.28	9.56	10.21

*Data represents mean ± standard deviation (n=3)

Parameters such as pH, TSS and Per cent acidity was analysed for A₃F₂ vegan beverage stored at room temperature (37 °C) are depicted in table 4.15 . Initial TSS of A₃F₂ vegan beverage stored at room temperature as well as refrigerated temperature was 12.34 °Brix. It can be observed from table 4.15. TSS decreased from 12.34 °Brix to 9.56 ° Brix in PET bottles and up to 10.21 °Brix in glass bottles during 15 days of storage. Initial acidity of A₃F₂ vegan beverage stored at room temperature was 0.13 % For both PET and glass bottles. At the room temperature acidity increased from 0.13 % to 0.30 % in PET bottles and 0.28 % in glass bottles. Values of acidity obtained for all plant-based beverage were close to the values quoted by Harjai and Singh (2007).

It was found that the pH of a vegan beverage called A₃F₂ dropped as storage time increased. Which ultimately increased its % acidity. Initial pH of sample recorded at 6.91 in both packing materials. Obtained pH was close agreement with values reported by Onuorh *et al.*, (2007). It was observed that pH was decreased from 6.91 to 5.73 in PET bottles and 6.01 in glass bottles.

Above findings indicate that glass bottles were significant over the PET bottles but vegan beverage was perishable in nature and undergoes drastic and depraved changes during the storage at room temperature. (Khodke *et al.*, 2014).

Table 4.16: Storage study of A₃F₂ at refrigerated temperature 4 ±1°C.

Parameter	pH		Titrable acidity (%)		TSS	
	PET	Glass	PET	Glass	PET	Glass
Days	Bottle	Bottle	Bottle	Bottle	Bottle	Bottle
0 th	6.90	6.90	0.13	0.13	12.34	12.34
3 th	6.90	6.90	0.13	0.13	12.30	12.30
6 th	6.85	6.90	0.14	0.13	12.00	12.29
9 th	6.81	6.85	0.16	0.14	11.90	12.25
12 th	6.75	6.79	0.17	0.14	11.78	11.98
15 th	6.71	6.75	0.19	0.15	11.30	11.90

*Data represents mean ± standard deviation (n=3)

Parameters such as pH, TSS and Per cent acidity was analysed for A₃F₂ vegan beverage stored at refrigerated temperature (4 °C) are depicted in table 4.16. Initial TSS of A₃F₂ vegan beverage stored at room temperature as well as refrigerated temperature was 12.34 °Brix. It was observed from table 4.15 TSS decreased from 12.34 °Brix to 11.30 °Brix in PET bottles and up to 11.90 °Brix in glass bottles during 15 days of storage. Initial acidity of A₃F₂ vegan beverage stored at refrigerated temperature was 0.13 % For both PET and glass bottles. At the refrigerated temperature acidity increased from 0.13 % to 0.19 % in PET bottles and 0.15 % in glass bottles. Values of acidity obtained for all plant-based beverage were close to the values quoted by Harjai and Singh (2007).

It was observed that pH of A₃F₂ vegan beverage stored at room temperature decreased with increase in storage period. It can be observed that pH was decreased from 6.91 to 6.71 in PET bottles and 6.75 in glass bottles. Khodke *et al.*, (2014) reported nearly close findings which indicate that glass bottles are significant over the PET. Storage in refrigerated condition gave good quality over the period.

Table 4.17: Storage study of A₃J₂ at room temperature 37 ±1°C.

Parameter	PH		Titrable acidity (%)		TSS	
	PET Bottle	Glass Bottle	PET Bottle	Glass Bottle	PET Bottle	Glass Bottle
0 th	6.91	6.91	0.13	0.13	12.34	12.34
3 th	6.73	6.83	0.20	0.18	12.29	12.32
6 th	6.47	6.80	0.24	0.22	12.01	12.87
9 th	5.16	6.75	0.28	0.26	11.56	11.99
12 th	5.59	5.70	0.29	0.27	10.21	10.90
15 th	5.75	5.71	0.31	0.29	9.57	10.22

*Data represents mean ± standard deviation (n=3)

Parameters such as pH, TSS and Per cent acidity were analysed for A₃J₂ vegan beverage stored at room temperature (30 °C) are depicted in table 4.17. Initial TSS of A₃J₂ vegan beverage stored at room temperature was 12.34 °Brix. It can be observed from table 4.16. TSS decreased from 12.34 °Brix to 9.57 °Brix in PET bottles and up to 10.22 °Brix in glass bottles during 15 days of storage. Initial acidity of A₃J₂ vegan beverage stored at room temperature was 0.13 For both PET and glass bottles. At the room temperature acidity increased from 0.13 to 0.31 in PET bottles and 0.29 in glass bottles. Values of acidity obtained for all plant-based beverage were close to the values quoted by (Khodke *et al.*, 2007). It was observed that pH of A₃J₂ vegan beverage decreases when stored at room temperature during storage period. Initial pH of sample recorded at 6.91 in both packaging materials. Obtained pH was close agreement with values reported by Onuorh *et al.*, (2007). It was observed that pH was decreased from 6.91 to 5.75 in PET bottles and 5.71 in glass bottles. Above findings indicate that glass bottles were significant over the PET bottles.

Table 4.18: Storage study of A₃J₂ at refrigerated temperature 4 ±1°C.

Parameter	PH		Titrable acidity (%)		TSS	
	PET Bottle	Glass Bottle	PET Bottle	Glass Bottle	PET Bottle	Glass Bottle
0 th	6.90	6.90	0.13	0.13	12.34	12.34
3 th	6.90	6.90	0.14	0.14	12.32	12.32
6 th	6.84	6.91	0.15	0.13	12.01	12.30
9 th	6.82	6.86	0.17	0.14	11.91	12.26
12 th	6.76	6.77	0.18	0.15	11.79	11.99
15 th	6.72	6.74	0.19	0.16	11.38	11.95

*Data represents mean ± standard deviation (n=3)

Parameters such as pH, TSS and Per cent acidity was analysed for A₃J₂ vegan beverage stored at refrigerated temperature (4 °C) are depicted in table 4.18. Initial TSS of A₃J₂ vegan beverage stored at room temperature as well as refrigerated temperature was 12.34 °Brix. It can be observed from table 4.16. TSS decreased from 12.34 °Brix to 11.38 °Brix in PET bottles and up to 11.95 °Brix in glass bottles during 15 days of storage. Initial acidity of A₃J₂ vegan beverage stored at refrigerated temperature was 0.13 For both PET and glass bottles. At the refrigerated temperature acidity increased from 0.13 to 0.19 in PET bottles and 0.16 in glass bottles. Values of acidity obtained for all plant-based beverage were close to the values quoted by Harjai and Singh (2007). It was observed that pH of A₃J₂ vegan beverage stored at room temperature decreased with increase in storage period. Initial pH of sample recorded at 6.91 in both packing materials. Obtained pH was close agreement with values reported by Onuorh *et al.*, (2007). It can be observed that pH was decreased from 6.91 to 6.72 in PET bottles and 6.74 in glass bottles. Khodke *et al.*, (2014) reported nearly close findings which indicate that glass bottles are significant over the PET bottles but vegan beverage is perishable in nature and undergoes drastic and depraved changes during the storage at room temperature. Storage in refrigerated condition gives good quality over the period.

4.13 Microbial analysis of selected vegan beverage sample

Microbial standard for pasteurized milk, flavoured milk and milk beverage described as total viable count not more than 50×10^3 CFU/ml and coliform should be ≤ 10 coliform/ml (FSSAI, 2015). The microbial analysis was carried out for determination of total viable count and coliform count at the refrigeration temperature at 4 °C. The analysis was done at the interval of 3 days due to the perishable nature of product. Prior to processing of vegan beverage, the raw milk samples was pasteurized and filled in sterilized bottles. Hence the microbial load for coliform count were not detected. Total plate count in the vegan beverage was seen after the certain interval.

Table 4.19: Total Plate Count and coliform count of A₃F₂ sample

Microbial analysis* at 4 °C		
Storage days	TPC (cfu/ml)	Coliform count
0 th	5×10^3	ND
3 th	6×10^3	ND
6 th	8×10^3	ND
9 th	11×10^3	ND
12 th	13×10^3	ND
15 th	15×10^3	ND

Table 4.19 revealed that microbial load i.e., total plate count and coliform count present in A₃F₂ vegan beverage stored at refrigeration temperature (4 °C). Which shows presence of microbes in the beverage sample. Table 4.19 clearly indicate that initial total plate count was 5×10^3 cfu/ml. It could be seen from table 4.19 as the storage period increased during refrigerated conditions the gradual increasing trend seen in the number of total plate count which increased from 5×10^3 cfu/ml to 15×10^3 cfu/ml. However, there was no evidence of coliform count. There is 2-3 % increase in the TPC during each three day of storage.

Maria and Victoria (2018) reported that by processing at an extremely high temperature and blanching results in reduction in the microbial load of soy milk. The pasteurisation temperature of 72°C for 15 minutes was sufficient because there were no microorganisms in the pasteurised sample. The present sample was acceptable according to regulations (FSSAI 2015).

Table 4.20: Microbial load Total Plate Count and coliform count of A₃J₂ sample

Microbial analysis* at 4 °C		
Storage days	Total Plate Count	Coliform count
0	6×10 ³	ND
3	7×10 ³	ND
6	10×10 ³	ND
9	12×10 ³	ND
12	15×10 ³	ND
15	17×10 ³	0.1× 10 ³

Table 4.20 revealed that microbial load i.e., total plate count and coliform count present in A₃J₂ vegan beverage stored at refrigeration temperature (4 °C). Which shows presence of microbes in the beverage sample. Illustrate 4.20 clearly indicate that initial total plate count was 6×10³ cfu/ml. It could be seen from table 4.20 as the storage period increased during refrigerated conditions the gradual increasing trend seen in the number of total plate count which increased from 5×10³ cfu/ml to 17×10³ cfu/ml. However, there was no evidence of coliform count Maria and Victoria (2018).

Maria and Victoria (2018) reported that by processing at an extremely high temperature and blanching results in reduction in the microbial load of soy milk. The pasteurisation temperature of 72°C for 15 minutes was sufficient because there were no microorganisms in the pasteurised sample. The present sample was acceptable according to regulations (FSSAI 2015)

4.14 Energy value of A₃F₂ and A₃J₂ vegan beverage

The theoretical energy value of A₃F₂ and A₃J₂ vegan beverage is presented in Table 4.21. Results revealed that energy provided by 100 ml of beverage was calculated theoretically by multiplying carbohydrates and protein with 4 Kcal and fat with 9 Kcal respectively (Gopalan *et al.*, 2004).

Table 4.21: Energy value of vegan beverage

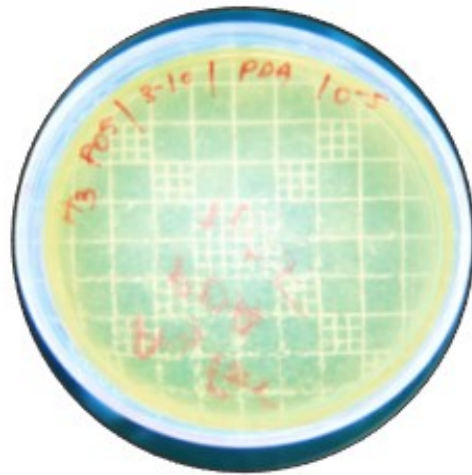
Parameter	C₀	A₃F₂	A₃J₂
Carbohydrate	12.96	20.16	39.36
Protein	7.72	11.24	12.04
Fat	35.99	43.47	44.37
Energy value (K.cal)	56.67	74.87	95.77

Results obtained by energy value calculation showed that there was the higher energy value for A₃J₂ sample prepared by addition of jaggery than that of A₃F₂ and C₀ sample. It is interesting to be mentioned that the energy value of prepared A₃F₂ and A₃J₂ vegan beverage was found to be comparatively lower than commercial marketed vegan beverages and also gives an additional benefit due to the presence of high mineral and total phenolic content due to presence of germinated soy milk.

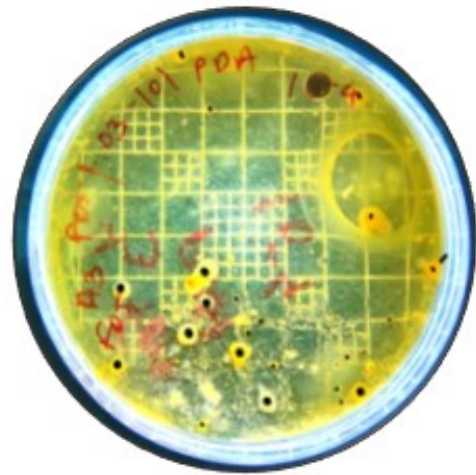
The A₃F₂ sample also rich in dietary fiber content and have low GI index. It can be concluded from the table 4.21 that 100 ml of A₃F₂ vegan beverage sample provide 74.87 K.cal and A₃J₂ provides 95.77 K.cal energy value.

4.15 Techno economic feasibility of A₃F₂ and A₃J₂ vegan beverage

The production cost of selected vegan beverage samples (A₃F₂ and A₃J₂) was worked out on the basis of cost of raw materials, quantity of finished product and also including processing, packaging and labelling cost. Total cost of prepared vegan beverage was estimated on pilot plant trials and depicted in table 4.22 and 4.22.

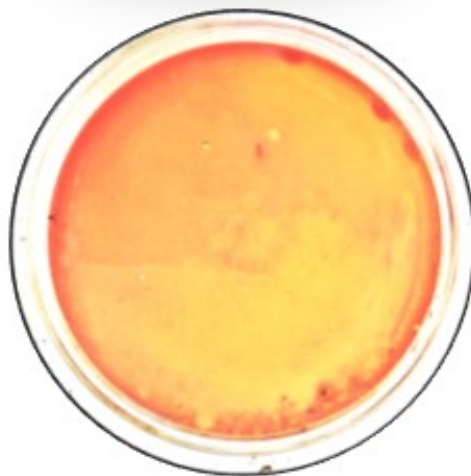


Day 1

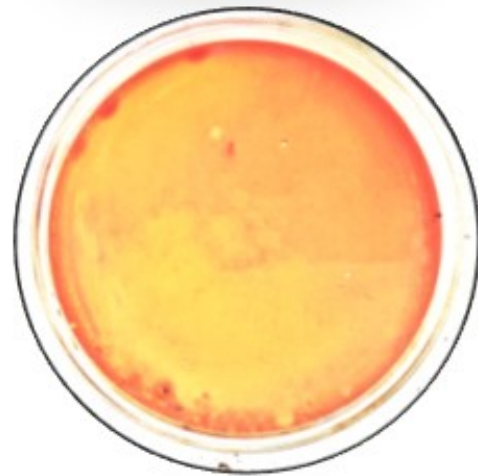


Day 15

Plate 4.1: Total Plate count (CFU/ml)



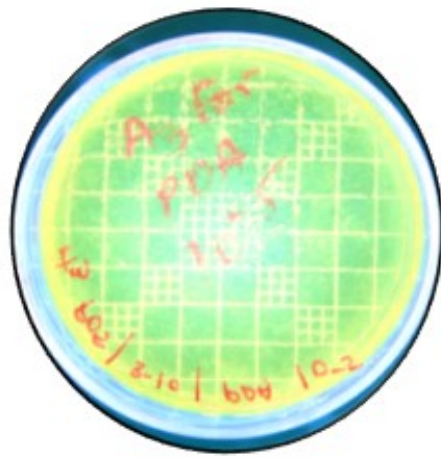
Day 1



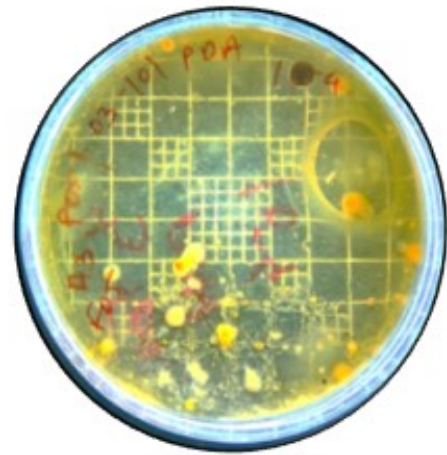
Day 15

Plate 4.2: Coliform Count (CFU/ml)

Microbial Analysis of selected A₃F₂ sample

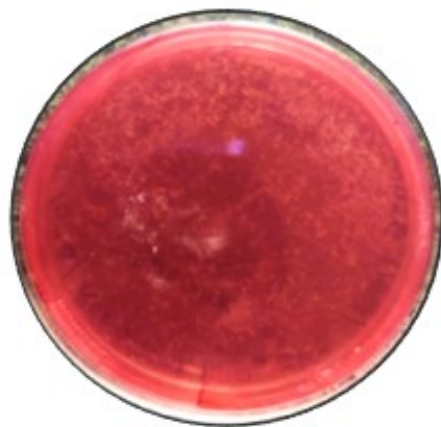


Day 1



Day 15

Plate 4.3: Total Plate count (CFU/ml)



Day 1



Day 15

Plate 4.4: Coliform Count (CFU/ml)

Microbial Analysis of selected A₃J₂ sample

4.22: Techno economic feasibility of A₃F₂ vegan beverage

Ingredients	Quantity (kg)	Rate (Rs/kg)	Milk obtained	Cost of production (Rs)
Soybean	1	60	6 lit	60
Coconut	0.66	180	2 lit	280
Almond	0.66	800	2 lit	532
FOS	0.012	300	1200 gm	360
Packaging	20 Glass bottles	15/bottle		300
Labelling	20 labels	5/label		100
Total cost of raw material (Rs)				1632
Processing cost at 20 per cent of raw material cost				326.4
Quantity of prepared vegan beverage (10 Lit)				10
Total cost of production of 10 lit of vegan beverage				1958
Cost of production of 1 lit (Rs.)				195.8
Cost of production of 200 ml (Rs.)				39.16

From table 4.22 that the cost of 10 Lit. of A₃F₂ vegan beverage packed in glass bottle was of Rs. 1958 (Rs. 19.58 for 200 ml). The available vegan beverages in market i.e., of branded companies at Rs. 50 per 200ml.

Prepared (A₃F₂) vegan beverage sample by using germinated soybean milk, coconut milk, almond milk and FOS was Rs. 10.84 lower than market beverage sample.

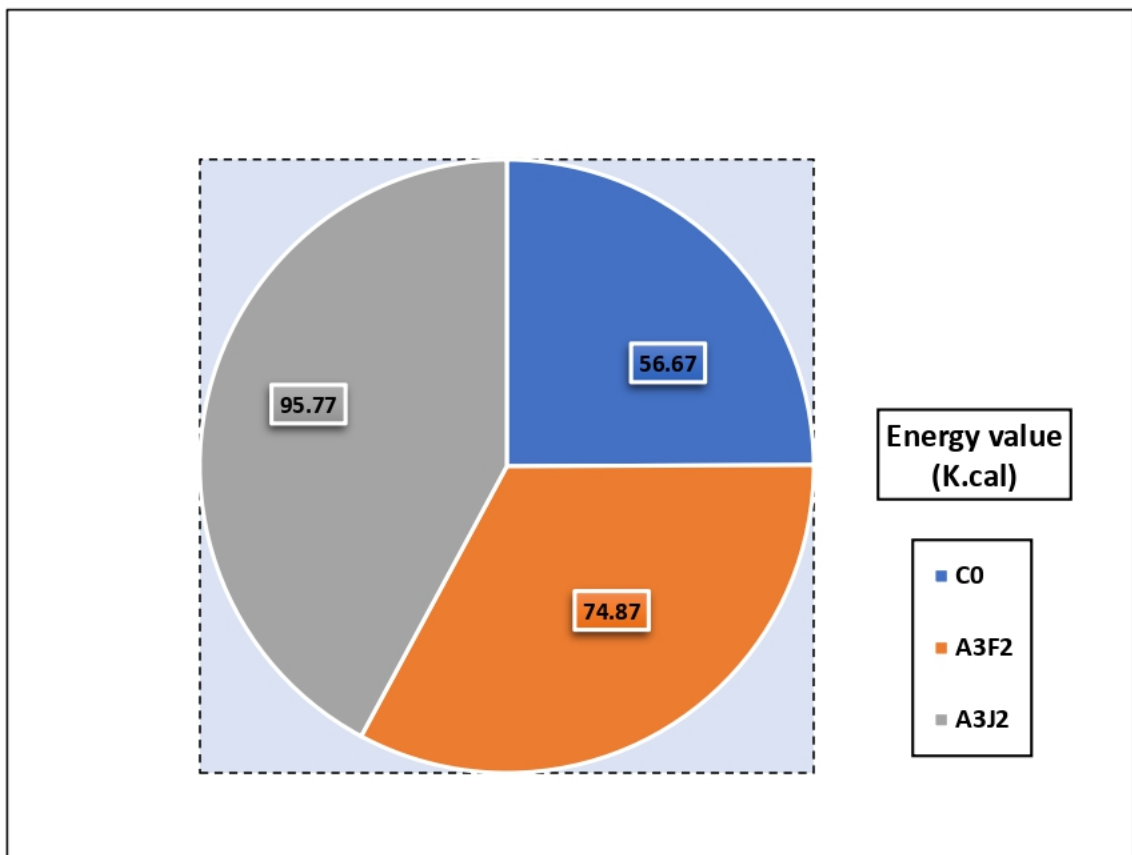


Fig 4.13: Energy value of control, A_3F_2 and A_3J_2 vegan beverage

4.23: Techno economic feasibility of A₃J₂ vegan beverage

Ingredients	Quantity (kg)	Rate (Rs/kg)	Milk obtained	Cost of production (Rs)
Soybean	1	60	6 lit	60
Coconut	0.66	180	2 lit	280
Almond	0.66	800	2 lit	532
Jaggery	0.008	160	800 gm	140
Packaging	20 Glass bottles	15/bottle		300
Labelling	20 labels	5/label		100
Total cost of raw material (Rs)				1412
Processing cost at 20 per cent of raw material cost				282.4
Quantity of prepared vegan beverage (10 Lit)				10
Total cost of production of 10 lit of vegan beverage				1694.4
Cost of production of 1 lit (Rs.)				169.4
Cost of production of 200 ml (Rs.)				33.88

The cost of A₃J₂ vegan beverage was illustrated in table 4.23. 10 Lit. of A₃J₂ vegan beverage packed in glass bottle was of Rs. 1694.4 (Rs. 33.88 for 200 ml). The available vegan beverages in market i.e., of branded companies at Rs. 50 per 200ml. Prepared (A₃J₂) vegan beverage sample by using germinated soybean milk, coconut milk, almond milk and jaggery was Rs. 16.12 lower than market beverage sample.

The above estimated cost of prepared A₃J₂ and A₃F₂ vegan beverages was found to be comparatively cheaper than the commercial marketed vegan beverages. The prepared vegan beverage is innovative refreshing drink i.e., definitely attract consumers for its consumption. Additionally, the established technology of the beverage can be commercially exploited by entrepreneurs and stakeholders because it proved its nutraceutical and functional features over an existing market sample, leading to customer preference.

CHAPTER- V
SUMMARY AND CONCLUSION

CHAPTER- V

SUMMARY AND CONCLUSION

The present investigation entitled “**Studies on development and quality assessment of vegan beverage by using soy, coconut and almond milk**” was structured in order to develop nutritional and functional vegan beverage with virtuous sensorial attributes. The developed beverage was further analysed for physicochemical, proximate and organoleptic testings. The results obtained in present study can be mentioned as follows:

Soybean contains more affordable and superior protein than expensive meat protein. soybean (*Glycine max*) is a great plant food known as the "miracle golden bean." not only is soy famous for its nutritional benefits, but it also has several positive health effects. Consuming raw soybeans is unhealthy because beans contain digestively challenging endogenous enzyme inhibitors. Since heat inactivates inhibitors like lectins. Thus, prior processing is necessary to improve the quality of soy-based foods and beverages. In the developed technology efforts have been made to formulate vegan beverage with best sensorial and nutritional qualities.

Soybean milk was made by using two different kind of treatments such as germination and use of sodium bicarbonate prior to the extraction of soybean milk. The results are analysed w.r.t. of proximate analysis and organoleptic attributes with the use of FOS (novel) and jaggery (traditional) sweeteners. During the germination phase, soybean undergoes numerous biochemical alterations. Many of these result in modifications that are directly related to and may be important chemical and physical factors in determining the quality of soy milk. Trypsin inhibitors, phytic acid, oligosaccharides, and components with lipoygenase activity are among the anti-nutritional components or unwanted compounds that was inactivated during germination.

Although germination was more effective than thermal treatment which lowers the heat-stable phytic acid level, cooking also helped to lower phytic acid levels. This is likely because phytic acid interacts with proteins or minerals to form insoluble complexes during cooking, hydrolyses into lower inositol polyphosphates, or degrades thermally. Phytic acid concentration in soy milk decreased due to result of

the combined effects of germination and heat processing. The best germination conditions were chosen, and soy milk produced from 28-hour-germinated soybeans under them showed much higher protein content, less carbohydrate, and a largely equivalent physicochemical profile to conventional soy milk Jiang *et al.*, (2013).

On the other hand, sodium bicarbonate method prior to extraction of soybean milk was analysed for nutritional and organoleptic qualities. Soaking and cooking soybean in 0.5 % sodium bicarbonate solution have positively reduces lipoxygenase activity which is primary cause of beany flavour in soybean milk. This also have greater protein extraction but not as good as germination method. When results are compared between these two methods w.r.t. sensory and nutritional effects. The study reveals that germination method prior to the extraction of soybean milk was best significant over sodium bicarbonate method in every manner.

Another aspect of this study is to use nuts such as coconut and almond to increase mineral profile and colour attributes. It is commonly considered of as a source of beneficial fat. The meat includes vital nutrients like magnesium, copper, iron, manganese, and protein in additional to fiber. In the present work part of vegan beverage was made by using best quality and matured coconut. Almonds have been consumed by people for thousands of years all across the world. Although California produces around 80% of the world's almonds. It is a powerful source of nutrients that are good for both your body and you. Almonds can aid you out if you're trying to build up your heart, bones. Eating almonds helps to boost levels of the good type of cholesterol, high-density lipoprotein (HDL), while decreasing levels of the bad type of cholesterol, low-density lipoprotein (LDL).

In the developed technology two types of sweeteners was used to impart good taste and mouthfeel as well as to also increase mineral and dietary fiber content. FOS i.e., fructooligosaccharide which is novel alternative sweeteners and have a lot of enticing characteristics, including low calories, no carcinogenicity, safety for diabetics, and bifidus-stimulating activity, The short fructose chains that make up FOS are beneficial for a number of things. FOS have low GI index and which have abundance of dietary fiber and zero fat content. Other sweetener such as Jaggery is traditional Indian sweeteners made from sugarcane in addition to sugar also known as *Gur* in India. Jaggery is frequently referred to as "medicinal sugar." It is utilised in

pharmaceutical formulations, and regular use of jaggery has been linked to an increase in human life expectancy. Jaggery has higher medicinal and nutritional values as compared to other sweeteners, easily available to the rural people and is highly recommendable by health experts. There are number of applications of jaggery in variety of foods and its use in households makes it a better choice as compared to sugar. Also, jaggery is associated with number of health benefits; which makes it a better choice than sugar. With the help to this best quality raw material technology was prepared and liked by most of the panel members and consumers.

The results obtained during present investigation are summarized and concluded as under:

- Physico-chemical characteristics of soybean were studied and revealed that length, width and thickness of soybean grain are 6.55 ± 0.04 mm, 5.61 ± 0.05 mm, 4.18 ± 0.06 mm respectively.
- Proximate content showed that the moisture, protein, fat, carbohydrate, ash and dietary fiber content for the raw soybean was 8.73 ± 0.33 , 34.58 ± 0.48 , 19.53 ± 0.72 , 27.32 ± 0.49 , 3.98 ± 0.16 and 5.21 ± 0.92 % respectively.
- Proximate content showed that the moisture, protein, fat, carbohydrate, ash and dietary fiber content for the raw coconut was 43.66 ± 0.40 , 4.00 ± 0.36 , 34.66 ± 0.57 , 13.73 ± 0.25 , 1.43 ± 0.11 and 3.43 ± 0.40 % respectively.
- Almond showed proximate composition w.r.t. moisture, protein, fat, carbohydrate, ash and dietary fiber as 4.45 ± 0.08 , 20.40 ± 0.74 , 55.21 ± 0.54 , 4.81 ± 0.07 , 2.95 ± 0.05 and 12.16 ± 0.40 % respectively.
- All the raw ingredients showed good mineral profile. Soybean was seen good source of calcium and potassium content while almond is good source of magnesium content. Coconut showed higher value for sodium and fiber content.
- After the extraction of milk moisture content of the germinated soy milk is slightly higher than soy milk made from sodium bicarbonate treatment and untreated soy milk i.e., 93.20 ± 0.25 , 91.41 ± 0.44 and 92.03 ± 0.07 % respectively. Protein content in germination method found to be higher than untreated and sodium bicarbonate treated method i.e., 3.18 ± 0.06 .
- Fat content in untreated soybean 3.99 ± 0.11 , fat content in sodium bicarbonate treatment was found to 2.48 ± 0.16 and lower fat percentage was present in soy

milk with germination method i.e., 1.56 ± 0.10 %. Carbohydrate content of untreated soybean milk, sodium bicarbonate method and germination method were 3.24 ± 0.21 , 2.48 ± 0.23 and 1.46 ± 0.22 % respectively. Mineral content of germination method, sodium bicarbonate method and untreated soybean milk was 0.60 ± 0.01 , 0.63 ± 0.02 and 0.51 ± 0.03 % respectively. Dietary fiber content of germinated soy milk and that of milk made with sodium bicarbonate method was 0.70 ± 0.01 , 0.54 ± 0.03 % respectively

- Statistical analysis revealed that germination method is significant to produce soy milk in case of protein, fat, carbohydrate and at far w.r.t. moisture, ash and dietary fiber content.
- Study revealed that the moisture content of almond milk, coconut milk were 87.20 ± 0.97 , 75.36 ± 0.55 % respectively. Coconut milk was higher in fat content i.e., 19.44 ± 0.48 % and that of almond milk was 3.40 ± 0.10 %. Carbohydrate content of almond milk was 5.44 ± 0.18 % and coconut milk was 2.50 ± 0.30 %. Ash content of almond milk and coconut milk was 0.92 ± 0.05 , 0.52 ± 0.02 % respectively. Dietary fiber in almond milk samples i.e., 0.99 %. The dietary content of coconut milk was 0.63 ± 0.11 %.
- Organoleptic evaluation of vegan beverage samples carried out with the help of trained and semi trained panel members using the 9-point hedonic scale. Formulations C₀, A₁, A₂, A₃, B₁, B₂, B₃ was made according to the table listed in chapter 3. A₃ vegan beverage sample was found to be statistically and scientifically significant over the all samples such as C₀, A₁, A₂, B₁, B₂, and B₃. Selected sample (A₃) have higher nutritional value and organoleptic values. Hence (A₃) sample was selected for further research.
- Different formulations from (table 3.2) were made using Fructooligosaccharide in varying proportion and most acceptable proportion selected on the basis of organoleptic attributes.
- After the organoleptic evaluation sample named A₃F₂ was statistically significant over other two samples w.r.t. like colour, sweetness, flavour, mouthfeel and OAA and selected for further studies
- Organoleptic evaluation of selected A₃ vegan beverage samples with jaggery was carried out with the help of trained and semi trained panel members using the 9-point hedonic scale

- Among all the runs A₃J₂ was statistically significant over other two samples w.r.t. like colour, sweetness, flavour, mouthfeel and OAA and selected for further studies along with A₃J₂.
- The chemical parameters like moisture content, protein, fat, carbohydrate, crude fiber and ash content for the A₃F₂ and A₃J₂ vegan beverage were estimated and obtained results are summarised as samples come under the category of perishable food commodity
- Moisture content in C₀, samples A₃F₂ was A₃J₂ was 92.03 ±0.07, 80.44 ±0.92 and 79.91 ±0.81 % respectively.
- Protein, carbohydrate, fat, and ash (minerals) content of A₃J₂ was 3.01±0.51, 4.93 ±0.46, 9.84 ±0.82 % respectively
- Protein, carbohydrate, fat, and ash (minerals) content of A₃F₂ was ranged from 2.81 ± 0.20, 4.83 ±0.46, 5.04 ±0.72, 0.67 ±0.89, % respectively.
- Study reveals that there were sudden increase in dietary fiber content in A₃F₂ vegan beverage sample was due to addition of FOS. Dietary fiber content of A₃F₂ sample was 6.40 ±0.91 and that of A₃J₂ was 0.65 ±0.62 %.
- The calcium, iron, potassium, magnesium, zinc and sodium content were A₃J₂ vegan beverage sample were 11.89 ±0.44, 1.92 ±0.57, 53.53 ±0.91, 33.76 ±0.34, 1.37 ±0.87, 24.74 ±0.68 % respectively that of A₃F₂ vegan beverage sample was 8.69 ±0.34, 10.40 ±0.38, 51.13 ±0.26, 28.16 ±0.56, 1.28 ±0.67, 23.06 ±0.45 respectively.
- The physico-chemical parameters such as pH of C₀ sample A₃F₂ and A₃J₂ sample was found 6.70 ±0.17, 6.90 ±0.02 and 6.90 ±0.02 respectively. The acidity (%) of A₃J₂ was higher than the other samples i.e., 0.24 ±0.01 %. The (%) acidity of C₀ and A₃F₂ was 0.22 ±0.01, 0.13 ±0.01 (%) respectively.
- The storage studies for the selected vegan beverage sample i.e., A₃F₂ and A₃J₂ was performed at room temperature i.e., 37 °C and refrigerated temperature 4 °C. Study reveals that both the samples acceptable in refrigerated condition over the 15 days. No harmful physicochemical change was seen in samples at 4 °C.
- The microbial analysis was carried out for determination of total viable count and coliform count at the refrigeration temperature at 4 °C. The analysis was done at the interval of 3 days due to the perishable nature of product. total

plate count and coliform count present in A₃F₂ vegan beverage stored at refrigeration temperature was 5×10^3 cfu/ml and A₃J₂ vegan beverage stored at refrigeration temperature was 6×10^3 cfu/ml which is below prescribed limit.

- A₃F₂ vegan beverage sample provide 74.87 K.cal and A₃J₂ 95.77 K.cal energy value.
- Prepared (A₃F₂) vegan beverage sample by using germinated soybean milk, coconut milk, almond milk and FOS was Rs. 10.84 lower than market beverage sample. 10 Lit. of A₃F₂ vegan beverage packed in glass bottle was of Rs. 1958 (Rs. 39.16 for 200 ml). The available vegan beverages in market i.e., of branded companies at Rs. 50 per 200ml.
- Prepared (A₃J₂) vegan beverage sample by using germinated soybean milk, coconut milk, almond milk and jaggery was Rs. 16.12 lower than market beverage sample. A₃J₂ vegan beverage packed in glass bottle was of Rs. 1694.4 (Rs. 33.88 for 200 ml). The available vegan beverages in market i.e., of branded companies at Rs. 50 per 200ml. Due to the therapeutic properties of the products and nutraceutical approach, which has positive health effects, the products are cost-effective for consumers.

CONCLUSION

- The present investigation clinched that there is tremendous need and scope for expansion of value-added products from pre-processed soybean which can be a part of daily diet. It is highly nutritious and functional beverage. Hence, it can be concluded that the good quality of vegan beverage can be prepared by using pre-processed soybean.
- According to the scientific study and statistical analysis the this developed technology short time germination of soybean prior to extraction of milk was more effective than other treatment for lowering the heat-stable phytic acid level with retention of all the nutritional and organoleptic parameters.
- It was also revealed that addition of almond and coconut milk in the definite ratio increases mineral profile and colour attributes. As coconut is rich in Lauric acid and almond helps to increase good HDL. In the prepared and selected product sample A₃F₂ and A₃J₂ composed of germinated soybean milk, coconut milk, almond milk on the ratio of 60:20:20 (ml). This proportion resulted in high organoleptic score and nutritional profiles. Developed as selected vegan beverage found to be overall acceptable.
- In recent years, Western developed countries have seen a rise in the number of vegans and those who consume plant-based diets, indicating that veganism is a modern and developing social phenomenon.
- Another reason to live a vegan lifestyle is to help slow down climate change by changing to a plant-based diet and taking personal responsibility for your carbon footprint. We contend that going vegan not only upholds the rights of animals but also addresses some of the systemic issues with the world food system. That's why many countries are adopting the rules and regulations for vegan foods.
- Moreover, in the present research it was also found that sample A₃F₂ is made with addition of FOS i.e., 12gm/100 ml, and sample A₃J₂ was made with addition of 8 gm/ 100 gm of powdered jaggery. Jaggery powder have good account of mineral profile and it imparts good after taste properties.

- FOS is novel sweetener and have low GI index which is beneficial to regulate blood glucose level and stay healthy. Storage study of both the vegan beverage sample found microbially stable up to 15 days in the refrigerated condition. Both the samples are had at far good storage capacity in glass bottles when compare with the PET bottles. Both the samples were at good organoleptic and physicochemical qualities and there is no evidence of coliform spoilage and total plate count was recorded within limit as per the regulations.
- The developed technology of preparation of vegan beverage was found to be feasible and this can be open new avenue to explore on commercial scale for the dairy and non-dairy industrialists.
- Future research work to be carried out as developed technology should be scale up on industrial level as it has nutraceutical benefits. Hence, it should be clinically assessed on human subjects in future work.

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Appendix – I

COLLEGE OF FOOD TECHNOLOGY, V.N.M.K.V. PARBHANI

Sensory evaluation of Developed vegan beverage by using soy, coconut and almond milk

Date: / /2022

Name of Evaluator :

Designation :

You are requested to evaluate the given samples and sensory qualities of the given samples. Express the acceptability of product by rating as per the given score point.

Sample code	Sensory Attributes				
	Color	Sweetness	Flavor	Mouthfeel	Overall acceptability
C ₀					
A ₁					
A ₂					
A ₃					
B ₁					
B ₂					
B ₃					

Hedonic rating scale: 9- extremely like, 8-Like moderately, 6-Like slightly, 5- Neither like nor dislike, 3-Dislike moderately, 2-Dislike very much, 1-Dislike extremely.

.....

Signature of Evaluator

CURRICULUM VITAE

Full name of the candidate : Shinde Siddheshwar Bhagwanrao
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Email id : Siddheshwarshinde26@gmail.com
Title of the thesis : “Studies on development and quality assessment of
vegan beverage by using soy, coconut and almond
milk”

Academic qualification:

Course/ Degree	Name of the college /Institute	University/ Board	Year of passing	Percentage/ CGPA	Class / Grade
S.S.C.	Shri Sarang Swami Vidyalay, Parbhani	Maharashtra State Board	2013	84.73 %	First
H.S.C.	Shri Shivaji College, Parbhani	Maharashtra State Board	2015	70.77 %	First
B. Tech (Food Technology)	College of Food Technology, Parbhani	Vasantrya Naik Marathwada Krishi Vidyapeeth, Parbhani	2020	8.54	Distinction

Place: Parbhani

Date: 03/02/2022



Signature of Candidate

Shinde Siddheshwar Bhagwanrao