Development of Value Added Product from Chicory Roots

Dissertation 1 Report

Submitted by,

Dinesh Suryakant Patil

11714425

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School of Agriculture

Lovely Professional University, Phagwara

Under the Guidance of

Sawinder kaur

Coordinator

Department of Food

Technology and

Nutrition School of

Agriculture

Lovely Professional University, Phagwara

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CERTIFICATE

This is to certify that **Dinesh Suryakant Patil** (Registration No.11707850) has personally completed M.Tech. Dissertation 1 entitled, **"Development of Value Added Product from Chicory Roots"** under my guidance and supervision. To the best of my knowledge, the present work is the result of his original investigation and study. No part of Dissertation has ever been submitted for any other purpose at any University.

The project report is appropriate for the submission and the partial fulfilment of the conditions for the evaluation leading to the award of Master of Food Technology.

Date: 12-05 -2018

Signature of supervisor

Sawinder Kaur

Coordinator

Department of Food Technology and Nutrition

School of Agriculture

Lovely Professional University

Phagwara, Punjab, India

TABLE OF CONTENT

1. INTRODUCTION:

Chicory (Cichorium intybus L.) has several names it is also known as “Succory”, “Hendibeh” or “Witloof” it’s a wild edible plant consumed in Lebanon, Arab countries and in different parts of the World. The family Cichorium (Asteraceae) consists of 6 species with major distribution areas in Europe and Asia (Bais & Ravishankar 2001). In several Asteraceae, inulin, acts as a reserve carbohydrate in stems, tubers, and taproots, inulin is a β-2,1 linked fructose polymer with a terminal glucose residue (Arkel et al, 2012). Chicory is a woody perennial herb having around 1m height with a fleshy taproot of up to 75 cm in length and large basal leaves (Gericke et al, 1997). From the past many years, chicory was grown by the ancient Egyptians used as a medicinal purpose, coffee substitute, and vegetable crop and was rarely used for animal feed. In the 1970s, it was discovered that the root of C. intybus contained inulin up to 40%, which has a minor impact on blood sugar and thus is suitable for Sugar patients (Judzentiene & badiene 2008) Up till now, C. intybus is developed for the production of inulin on an industrial scale (vergauwen et al, 2012). The name derived from Greek and Latin. Cichorium means field and intybus is Greek word means “to cut”, because of the leaves, and from the Latin tubus to specify the hollow stem (European Medicines Agency 2013) Chicory can grow wild, in its natural environment, in fields, roadsides or home gardens. Chicory consists of the flower having blue color, roots and “wild” green leaves. Roots and Leaves are the edible parts of the plant. Chicory mainly eaten in cooked dishes mainly mixed with lemon juice, olive oil, salt and fried onions or raw in green salads (Ravishankar & Bais, 2001). Bushy edible plants are green leafy vegetables that are a excellent source of dietary fibers, minerals, vitamins, antioxidants and phytochemicals and contribute to the prevention of diseases such as cardiovascular problems, gastrointestinal problems, and diabetes (Allende et al., 2006; Barat et al., 2007). However, the utilization of wild edible plants has been declining lately due to ecological and economic factors and changes in lifestyle/cooking habits (Jeambey, 2005; Batal et al., 2009). Therefore, it is necessary to improve the production and consumption of green leafy vegetables in local diets and find efficient preservation methods which are suitable for keeping these plants “fresh” with respect to good quality and nutritional content.

Chicory is a biyearly plant with several applications in the food industry. The roots of chicory are used in dried and roasted form and used for blending with coffee to add flavour; the fresh leaves are used in salads and vegetable dishes, and the chicory extracts are used for the production of invigo-rating beverages (Milala et al., 2010).

The wastes generated from the chicory (leaves and peel) are very hardly used in processing industry. The management of vegetable and fruit wastes seems to be advisable and is of growing scientific interest (Peschel et al., 2006). In recent studies it was demonstrated that the Cichorium species possesses both pro- and antioxidants (Papetti et al., 2006), and additional researchers have pointed to a phenolic fraction with potential antiradical activity of chicory (Gallori et al 2005). However, not only phenolic compounds can be responsible for the in free radical scavenging activity of chicory preparations. For example, it is proposed that sugars themselves, especially sucrose and fructans, can also act as radical scavengers in plant cells (Valluru et al., 2009). The previous data, in connection with a new scientific approach to radical scavenging activity as the major health-promoting property linked with dietary fibre (Goni et al., 1996), encouraged us to study non-inulin fraction of chicory by-products as potential health promoting agents improving physiological activity of inulin.

Cichorium intybus is a plant grown in Eurasia and in parts of Africa for its medicinal important, even with its long tradition of use; the plant is not described in the European Pharmacopoeia or in any official Pharmacopoeia of a European Union member state (European Medicines Agency, 2008). However, due to its common distribution, different parts of the plant have been used in conventional medicines globally (Akkola et al., 2012). Important phytochemicals are distributed throughout the plant, but the main contents are present in the root (Street et al., 2013). This study focuses on the economic and culturally important medicinal & Industrial uses of C. intybus.

2. PROBLEM BACKGROUND:

Root chicory has been grown in Europe as a coffee substitute, although chicory might have originated in France, Italy, and India. It studies shows that the root contains up to 20% inulin, a polysaccharide similar to starch. Chicory was commercialized but only with a limited use like Inulin extraction, Coffee Substitute. Mainly research’s carried on chicory for the Inulin but it was found in studies that chicory has a many other chemical constituents like phenolic compounds present in chicory, antioxidant, antimicrobial activity. It can be used for treating various disorders such as diabetes and cardiovascular diseases. Therefore, the present research has been planned to development of value added products from chicory which can be commercialized. Development of products like Chicory juice, Chicory root powder from crude extract, fermented product as chicory root pickle, use of chicory flour in muffins as sugar and fat replacement.

3. REVIEW OF LITRATURE

3.1 Traditional uses of chicory:

Chicory has a long history of therapeutic use both in areas where it is indigenous and in areas where it has been introduced. Different preparations of this plant are in use to treat various symptoms and ailments. According to the European monograph, chicory roots having traditional uses includes relief from symptoms related to mild digestive disorders (abdominal fullness, flatulence, and slow digestion) and loss of appetite (European Medicines Agency 2012). During the digestive disorders and loss of appetite the use of a tea of the roots was already reported in 1938 by Madaus (European Medicines Agency, 2012.).

In purification of blood, catarrh of the stomach, jaundice the roots are used. The use of aqueous root extracts as a light-sensitive plant remedy for malaria was described in folkloric report prior to the wars in Afghanistan. The light-sensitive compounds of C. intybus root are sesquiterpene lactones lactucin and lactucopicrin antimalarial compounds have been identified (Bischoff et al. 2004). The roots are used as a bitter tonic or stomachic, mild laxative, to support liver function and diuresis (European Medicines Agency, 2012.). The flowers of the chicory plant are used as a herbal treatment of everyday ailments such as a tonic and appetite stimulant and as a treatment of, gastroenteritis, gallstones, sinus problems, bruises and cuts. (judzentiene 2008).

Chicory is traditionally used in slimming diets as a adjuvant. Traditionally used to promote renal elimination functions (Ministry of social affairs and solidarity 1990). Jigrine is a commercial product of India used for the treatment of various diseases of the liver and Chicory seeds are one of the main ingredient (Ahmed et al., 2003). Other parts of chicory are also used for liver disorders, namely, aerial parts in Bosnia and Herzegovina (Hanlidou et al., 2004) and roots in Serbia and India (Low et al., 2007).

3.1.1Traditional medicinal uses of chicory:

Table no.1 Traditional medicinal uses of Chicory

Country	**Traditional use**	**Plant part**
Afghanistan	Malaria	Root
Bosnia & Herzegovina	Diarrhea, Strengthening the prostate & other reproductive organs, pulmonary cancer, hangover, and purification of biliary tract.	Aerial part, flowers, roots
Bulgaria	Cholagogue stimulant / gastric secretion, hypoglycemic	Roots, aerial part
India	Liver disorders, Diabetes, Jaundice, liver enlargement, Rheumatism & gout, cough relief	Seed, Whole Plant, Root
Italy	Blood Cleansing, High blood pressure, Blood purification, Arteriosclerosis, Antiarthristis, Antipasmodic, Digestive	Leaves
Iran	Eupeptic, stomachic,	Whole plant

	depurative, choleretic, laxative, hypotension, tonic, and antipyretic	
Jordan	Internal hemorrhage, sedative in typhoid	Whole plant
Pakistan	Diabetes	Root
South Africa	Jaundies, Tonic	Leaves, Steam , roots
Turkey	Cancer, Kidney stone, Wound healing, Hemorrhoids, urinary disorders	Root, Leaf, Aerial

Source: (Street et al, 2013)

3.2 Chemical Constituents:

It was clear that chicory leaves contain high level of protein (14.70%) ash (10.91) crude ether extract (3.68%) & crude fiber (16.78%) & had low concentration of total carbohydrates (68.50%) compared to with its roots. On the other hand, the roots of chicory were characterized by its high concentration of inulin (44.69%) (Monti et al.,2005). Crude protein range from 8.56 – 15.73% and 9.53- 13.75% respectively.

in methanolic extracts Chicoric acid has been identified as the major compound of chicory (Table 2)

Table 2: Compounds isolated and identified from cichorium intybus (chicory).

Compounds	Reference
Malic acid, Caffeic acid, 3-Caffeoylquinic acid, 5-Caffeoylquinic acid, 4-Caffeoylquinic acid, cis-5-Caffeoylquinic acid, cis-Caftaric acid, trans-Caftaric acid, 5-Caffeoylshikimic acid, 5-p-Coumaroylquinic acid, Quercetin-3-O-glucuronide-7-O-(6”-Omalonyl)-glucoside, Kaempferol-3-O-glucosyl-7-O-(6”-Omalonyl)-glucoside, Dimethoxycinnamoyl shikimic acid, Kaempferol-3-O-sophoroside, Isorhamnetin-7-O-(6”-O-acetyl)-Glucoside, 5-O-Feruloylquinic acid, Dicaffeoyltartaric acid (chicoric acid), Kaempferol-7-O-glucosyl-3-O-(6”malonyl)-glucoside, Delphinidin-3-O-(6”-O-malonyl)-glucoside-5-O-glucoside, Cyanidin-3,5-di-O-(6”-O-malonyl)-Glucoside, 3,5-Dicaffeoylquinic acid, Cyanidin-3-O-(6”-O-malonyl)-glucoside, Petunidin-3-O-(6”-O-malonyl)-Glucoside, Cyanidin, Cyanidin-3-O-galactoside, Cyanidin-3-O-(6”-O-acetyl)-glucoside, Malvidin-3-O-glucoside, Pelargonidin-3-O-monoglucuronide, 4-O-Feruloylquinic acid, Apigenin-7-O-glucoside, Chrysoeriol-3-O-glucoside, Tricin-3-O-glucoside, 1,3-Dicaffeoylquinic acid, 1,4-Dicaffeoylquinic acid, 3,4-Dicaffeoylquinic acid, Quercetin-7-O-galactoside, Quercetin-3-O-(6”-O-malonyl)-Glucoside, Quercetin-7-O-	Carazzone et al., 2013

(6”-O-acetyl)-glucoside, Quercetin-7-O-glucuronide, Quercetin-7-O-(6”-O-acetyl)-glucoside, Kaempferide glucuronide, Kaempferol-7-O-glucoside, Kaempferol-7-O-rutinoside, Quercetin-7-O-p-coumaroylglucoside, Isorhamnetin-7-O-neohesperidoside, Kaempferol-7-O-(6”-O-malonyl)-glucoside, Kaempferol-7-O-glucuronide, Kaempferide-3-O-(6”-O-malonyl)-Glucoside, Kaempferol-3-O-glucuronide, Kaempferol-3-O-glucuronide-7-Oglucoside, Kaempferol-3-O-(6”-O-malonyl)-Glucoside, Kaempferol-3-O-glucoside, Myricetin-7-O-(6”-O-malonyl)-glucoside, Kaempferol-7-O-neohesperidoside, Kaempferol-7-O-(6”-O-acetyl)-glucoside, Kaempferol-3-O-(6”-O-acetyl)-glucoside.	
Lactucin, Lactucopicrin, 8-Deoxylactucin, Jacquilenin, 11β,13-Dihydrolactucin, Crepidiaside B, Cyanidin 3-O-p-(6-O-malonyl)-Dglucopyranoside, 3,4β-Dihydro-15-dehydrolactucopicrin, Magnolialide, Ixerisoside D, Loliolide, Cichorioside B, Sonchuside A, Artesin, Cichoriolide, Sonchuside C, Cichopumilide	Kisiel and K. Zieli´nska 2001
Delphinidin 3,5-di-O-(6-O-malonyl-β-D-glucoside), Delphinidin 3-O-(6-O-malonyl-β-Dglucoside)-5-O-β-D-glucoside, Delphinidin 3-O-β-D-glucoside-5-O-(6-O-malonyl-β-D-	Norbak et al., 2002

glucoside), Delphinidin 3,5-di-O-β-D-glucoside, 3-O-p-Coumaroyl quinic acid.	
Oxalic acid, Shikimic acid, Quinic acid, Succinic acid	Papetti et al., 2013
Cyanidin 3-O-β-(6-O-malonyl)-Dglucopyranoside, Cyanidin 3-O-p-(6-O-malonyl)-Dglucopyranoside	Bridle et al., 1984
(7S,8R)-3′-Demethyl dehydrodiconiferylalcohol-3′-O-β-glucopyranoside, 4,5-Dicaffeoylquinic acid, Crepidiaside A,	Malarz et al., 2013
Cichoralexin	Monde et al., 1990
Putrescine, Spermidine, β-Sitosterol, Campesterol, Stigmasterol	Krebsky et al., 1999

The major fractions are comprised by aliphatic compounds and their derivatives and terpenoids comprise minor constituents of the plant. The flowers of chicory contain saccharides, methoxycoumarin cichorine, essential oils, flavonoids (Judzentiene & Badiene., 2008) and the blue color of the perianth contributing anthocyanins (Wang & Cui 2011). Octane, hexadecane, pentadecanone, n-nonadecane and a tentatively identified compound have been found as principal volatile components (Badiene et al., 2008)

The mineral content of chicory root was found to be relatively less than chicory levaes. The macro elemments present in chicory are Ca, K, Na , Mg and the micro elements Fe, Zn, Mn, Cu (Schittenhelm 2001)

3.3 Phenolic compound content as methanolic extract:

Yield of methanolic extract were about 23.16% in leaves & 10.75% in roots.

Leaves : (Mona et al. 2004)

Methanolic Extract Yield : 23.16%

Total Phenolic Content : 26.4% (+/- 1.05)

Phenolic compound : Gallic Acid (1.96%), Protocatechuic Acid (2.50%), Chlorogenic Acid (17.84%), P. hydroxybenzoic Acid (11.04%), Caffeic Acid (35.22%), Iso Vanillic Acid (1.97%), P. Coumaric Acid (9.65%), Other Compounds / Unknown compounds (19.46%)

Roots : (Mulinacci et al. , 2001)

Methanolic Extract Yield : 10.75%

Total Phenolic Content : 20.0% (+/- 0.90)

Phenolic compound: Protocatechuic Acid (1.77%), Chlorogenic Acid (10.85%), Caffeic Acid (24.36%), m.coumaric acid (27.90%), p.cumaric acid (25.03%),Unknown Compounds (10.09%)

3.4 Pharmacological activity:

3.4.1Antimicrobial activity:

The antibacterial activity of the organic acid-rich extract of fresh red chicory (C. intybus var. sylvestre) was tested against periodontopathic bacteria including Streptococcus mutans, Actinomyces naeslundii, and Prevotella intermedia. The compounds identified from the active extract include quinic acid, succinic acid, oxalic acid and shikimic acid. All of the organic acids were found to decrease biofilm formation and adhesion of bacteria to the cells, with different levels of efficacy. These compounds also induced biofilm disruption and detachment of dead cells for the cultured substratum (Papetti et al, 2000).

3.4.2 Antimalarial Activity:

The light-sensitive sesquiterpene lactones Lactucin and Lactucopicrin, extracted from Cichorium intybus roots, as antimalarial compounds. Both substances exhibited in vitro, activity against a HB3 clone of a strain Honduras-1 of Plasmodium falciparum. Inhibitory lactone concentrations that completely prevented parasite growth in cell cultures were 10 μg/ml for Lactucin and 50 μg/ml for Lactucopicrin (Bischoff et al, 2004).

3.4.3 Antioxidant Activity:

The DPPH radical scavenging activity of a polyphenols-rich fraction of C. intybus has been investigated (Heimler et al., 2009). The anti- and prooxidant activities of Cichorium species were studied in chemical as well as biological systems. In the case of chemical systems, the antioxidant activity of water-soluble compounds in C. intybus var. silvestre was established in the coupled model of linoleic acid and β-carotene. A pro-oxidant activity of some of the chemical components was recorded initially which notably diminished with time and/or thermal treatment. Thereafter, the antioxidant activity of the raw juice and its fractions persisted. The molecular weight ranges of the antioxidant fractions of raw juice were also identified based on dialysis (Papetti et al., 2006).

Two varieties of chicory, namely, C. intybus var. Silvestre and C. intybus var. foliosum, have been investigated for their antioxidant (antiradical) activities in two distinct biological systems. The lipi peroxidation assay has been carried out on microsomemembranes of rat hepatocytes after the induction of oxidative damage by carbon tetrachloride. The antiradical activity was expressed as the protective activity against lipid peroxidation and calculated as the percentage decrease in hydroperoxide degradation products. The second biological system used was the cultures of S. aureus after treatment with cumene hydroperoxide. The percentage increase of growth of bacteria was noted after the treatment with juices of chicory varieties. In both systems, the juices of chicory varieties showed strong antiradical activities (Gazzani et al., 2000). Red chicory (C. intybus var. silvestre) was studied for its polyphenol content and the antioxidant activity was evaluated by using the synthetic 2,2-diphenyl-1-(2,4,6-trinitrophenyl) hydrazyl radical and three model reactions catalyzed by pertinent enzymatic sources of reactive oxygen species, namely, xanthine oxidase, myeloperoxidase, and diaphorase. Total phenolics were significantly correlated with the antioxidant activity evaluated with both the synthetic radical and the enzyme-catalyzed reactions.Onamolar basis, redchicory phenolics were as efficient as Trolox (reference compound) in scavenging the synthetic radical (Lavelli 2008) . The aqueous-alcoholic extracts of the aerial parts of C. intybus also inhibited xanthine oxidase enzyme dose dependently (Pieroni et al., 2002). In another study, alongwithDPPHradical scavenging activity, C. intybus also exhibited inhibition of hydrogen peroxide and chelation of ferrous ion (El & Karakaya, 2004).

3.4.4 Antidiabetic effects:

An ethanolic extract of Cichorium intybus herb for its anti-diabetic activity on male Sprague Dawley rats treated streptozotocin. A dose of 125 mg/kg body weight influenced oral glucose tolerance test and the same amount given orally for 14 days reduced serum glucose by 20%, triglycerides by 91% and cholesterol by 16%. No changes in the insulin secretion were observed during the experiment, whereas hepatic Glc-6-Pase activity was markedly reduced (Pushparaj et al., 2007).

3.4.5 Anti-Inflammatory Activity :

The inhibition of TNF-α mediated cyclooxygenase (COX) induction by chicory root extracts was investigated in the human colon carcinoma (HT 29) cell line.Theethyl acetate extract inhibited the production of prostaglandin E2 (PGE2) in a dose-dependent manner. TNF-α mediated induction of COX-2 expression was also suppressed by the chicory extract (Cavin et al., 2005).

3.4.6 Antitumor activity:

A tumour-inhibitory effect of an ethanolic extract of chicory root against Ehrlich ascites carcinoma in mice. Significant results were obtained at doses from 300 to 700 mg/kg (Hazra et al., 2002).

3.4.7 Hepatoprotective Activity:

The folkloric use of C. intybus as a hepatoprotectant has been well documented. It is one of the herbal components of Liv-52, a traditional Indian tonic used widely for hepatoprotection. In a randomized, doubleblind clinical trial conducted on cirrhotic patients, Liv-52 medication reduced the serum levels of hepatic enzymes, namely, alanine aminotransferase and aspartate aminotransferase. It also reduced the Child-Pugh scores and ascites significantly (Fallah et al., 2005). Another polyherbal formulation, Jigrine, contains the leaves of C. intybus as one of its 14 constituents. Jigrine was evaluated for its hepatoprotective activity against galactosamine-induced hepatopathy in rats. The pretreatment of male Wistar-albino rats with jigrine significantly reduced the levels of aspartate transaminase, alanine transaminase, and urea and increased the levels of blood and tissue glutathione. Histopathological examination of the liver revealed that jigrine pretreatment prevented galactosamine toxicity and caused a marked decrease in inflamed cells (Aqil et al., 2005).

The aqueous-methanolic extract of the seeds of C. intybus has been investigated for the hepatoprotective activity against acetaminophen and carbon tetrachloride-induced liver damage inmice. It was found to decrease both the death rate and the serum levels of alkaline phosphatase, glutamyl oxaloacetate transaminase, and glutamyl pyruvate transaminase (Gilani & janbaz

1994). In analogous studies, the antihepatotoxic activity of the alcoholic extract of the seeds and aqueous extracts of the roots and root callus of C. intybus was estimated. The oral administration of these extracts in albino rats led to amarked decrease in the levels of hepatic enzymes. Also, histopathological examination of the liver showed no fat accumulation or necrosis after the treatment (Ahmed et al., 2003). Similar studies have established the hepatoprotective effect of esculetin, a phenolic compound, and cichotyboside, a guaianolide sesquiterpene glycoside reported from C. intybus (Khan et al., 2008).

The phenolic acid-rich seed extract of C. intybus was evaluated for its efficacy against hepatic steatosis in vitro and in vivo. The in vitro model of hepatic steatosis was created by incubation of the HepG2 cells with oleic acid leading to intracellular accumulation of fat. The seed extract was effective in decreasing the deposited fat from the cells in case of administration after the initial fat deposition (i.e., non simultaneous administration with oleic acid). However, in case of simultaneous administration of seed extract and oleic acid, the extract could not protect the cells from steatosis except at very high doses.

The extract also led to the increased release of glycerol (an indicator of triglyceride degradation) in steatotic cells. In case of nonsimultaneous administration, the extract was found to upregulate the expression of SREBP- 1c and PPAR-α genes leading to restoration of normal levels of corresponding proteins. In the in vivo model of hepatic steatosis, namely, diabetic rats, treatment with seed extract resulted in significant decrease in fat accumulation and fibrosis (Khaghania et al., 2013).The hepatoprotective activity of C. intybus has been correlated to its ability to inhibit the free radical mediated damage. A fraction prepared from the ethanolic extract of the leaves was assessed for preventive action on the free radical mediated damage to the deoxyribose sugar of the DNA (obtained from calf thymus). A dose-dependent decrease in the DNA damage was observed in the present assay (Sultana et al., 1995).

3.5 Food technological application:

Applications of Powder chicory root in some foods.

1) Beverage: Coffee

2) Crackers

3) Frozen Desserts

4) Bakery Food: Bread

1) Beverages (Coffee) :

The powder of roasted chicory was used to replace 50-100% coffee.

Chicory is used as substitute for coffee.

Also reported that Nescafe blend chicory root(50%) had coarse perforated and light colour granules. (Mona et al., 2009)

2) Crackers :

The cracker were prepared according to the recipe and method (Adb-El-Rahim et al., 2003)

Chicory used as a Wheat flour (10%) and Fat replacer (25%).

3) Frozen Desserts: Yoghurt –Ice Cream

In yoghurt ice cream preparation the different trials taken for the improving the Colour, Flavour, Texture, Sweetness, Hardness, Melting rate etc.

The level of chicory root extract increases the score of colour of product was increased.

Chicory root extract shows positive effect on the flavour . Increase in the level of dried chicory root extract, the flavour of the product also increased.

Increase in the level of dried chicory root extract the texture increases.

In case of sweetness dried chicory root extract increases the score of sweetness.

Positive effect observed in case of increasing the hardness of yoghurt ice-cream.

Increase in chicory root extract decrease in melting rate.

Over all acceptability results shows that the chicory affects positively on all factors. (Kumar et al., 2017)

4) Bakery products : Rey Bread

In rey bread the chicory powder is used 9% for the improvement of fructans content.

The use of chicory powder is also affect on increasing consumer acceptance by its intrinsic aroma and sweet aftertaste.

It is necessary to indicate, that fructans concentration in bread could be affected not only by pH or acidity, but of increased processing temperature too, as higher than 90°C. (Gudreniece et al., 2017)

3.6. Removing the Bitterness

The bitter substances are primarily the two sesquiterpene lactones lactucin and lactucopicrin. Other ingredients are aesculetin, aesculin, cichoriin, umbelliferone, scopoletin, 6,7-dihydrocoumarin, and further sesquiterpene lactones and their glycosides.(Bais et al., 2001)

There are two different methods of debittering of chicory

1) Soaking
2) Roasting

Table :3 Effect of different treatment for removal of bitterness of chicory

Treatments	**Time of Soaking And roasting**	**Inulin%**	**Bitter taste**	**Loss of inulin%**
Control	-	44.69±0.27	+++++	-
Soaking in water at a ratio of 1:4 at R.T.	24hrs.	35.99±0.40	Slightly	19.47
Soaking in water at a ratio 1:4 at temp. 45°C	1hrs. 2hrs. 3hrs.	37.61±0.54 29.89±0.28 24.19±0.38	+++ ++ +	15.84 33.12 45.87
Soaking in Citric acid solution 0.75% 1:10	24hrs. 48hrs. 72hrs.	32.34±0.80 29.55±0.42 15.02±0.28	++ + -	27.63 33.87 66.39
Soaking in Ethanol 80% 1:10	2hrs. 3hrs. 24hrs.	43.57±0.42 42.82±0.29 38.90±0.12	+++++ +++++ +++	2.51 4.18 12.96
Roasting at 140°C	20min 30min	38.05±0.08 37.51±0.38	++ +	14.86 16.07
Roasting	30min	39.13±0.37	+	12.44

at140°C + 10% treacle & 10% oil				

Source: Mona et al., 2009

The processs of debittering of chicory causes a loss in Inulin concentration, this reduction was based on type of method used for debittering. There are the different types of debittering are shown (Table 3).

As table shows that the reduction in percentage of inulin was considerably higher in soaking treatment than roasting. This could be due to the solubility of inulin in water and the low pH value of citric acid and its effect on inulinase enzyme activity.

4. PROPOSED RESEARCH OBJECTIVE

1) Preparation of Chicory Root Juice

2) Preparation of Chicory Root Powder by using crude juice extract

3) Preparation of Chicory Pickle as a source of Dietary fiber

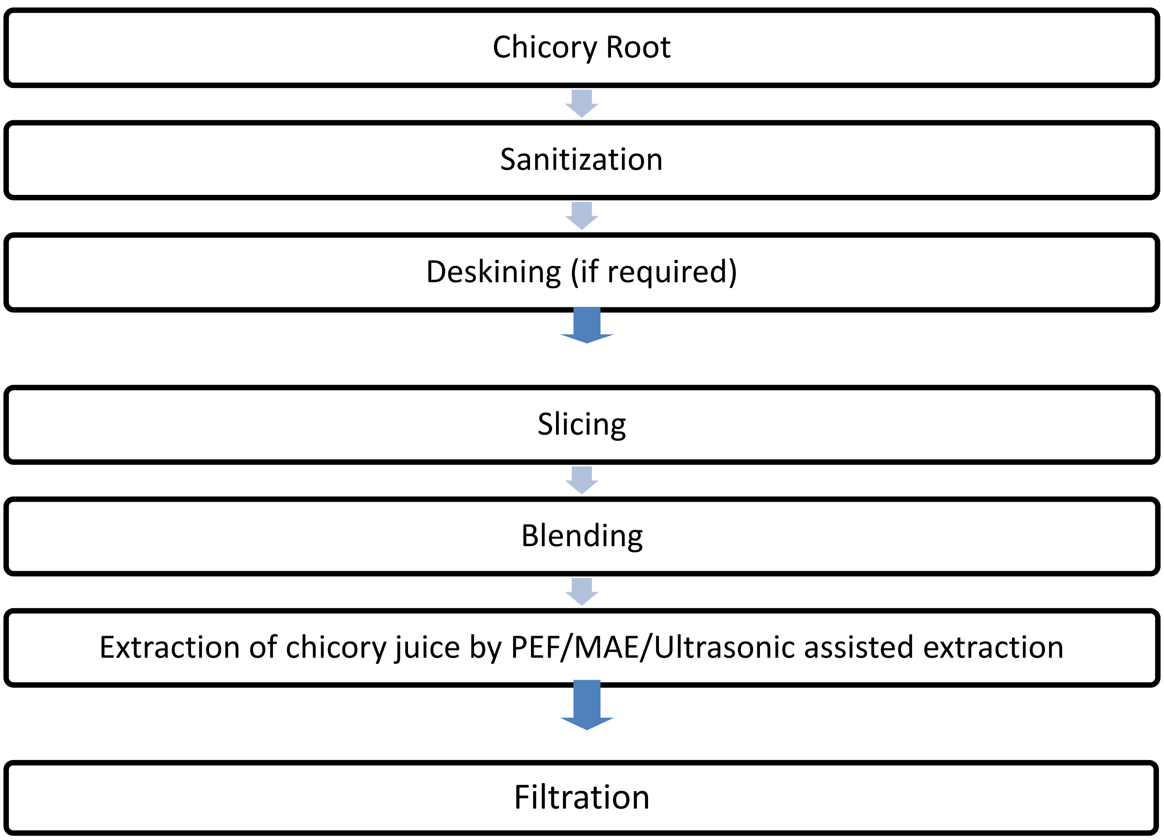
4) Preparation of sugar and fat reduced muffins using Chicory Flour

5.0 PROPOSED RESEARCH METHODOLOGY:

5.1 Detailed plan work

5.1.1 Objective 1: Preparation / Extraction of chicory root juice

In contrast to the conventional inulin extraction process, which requires high temperature and long time, alternative technologies have been carried out, including supercritical carbon dioxide (CO_2) ultrasound, simultaneous ultrasonic/microwave and pulsed electric field (PEF) assisted extraction (Vorobiev et al., 2013)



Proximate analysis:

- Dry mass
- Soluble matter
- Inulin
- Carbohydrate
- Pectin
- Protein
- pH
- Viscosity
- Jucie Purity
- Antioxidant Activity

5.1.2 Objective 2: Preparation of Chicory Root Powder:

Chicory Root

↓

Washing

↓

Cutting

↓

Drying of Chicory Root

↓

Roasting (150° c for 20-30min) [Depends on Use]

↓

Pulverization / Powder

5.2.2.

Chicory Root

↓

Washing

↓

Slicing and Grinding

↓

Extraction (Diffusion in hot Water)

↓

Filtration

↓

Concentration by Evaporation (70°c Until 25° brix)

↓

Drying (50°/60°/70°c)

↓

Grinding

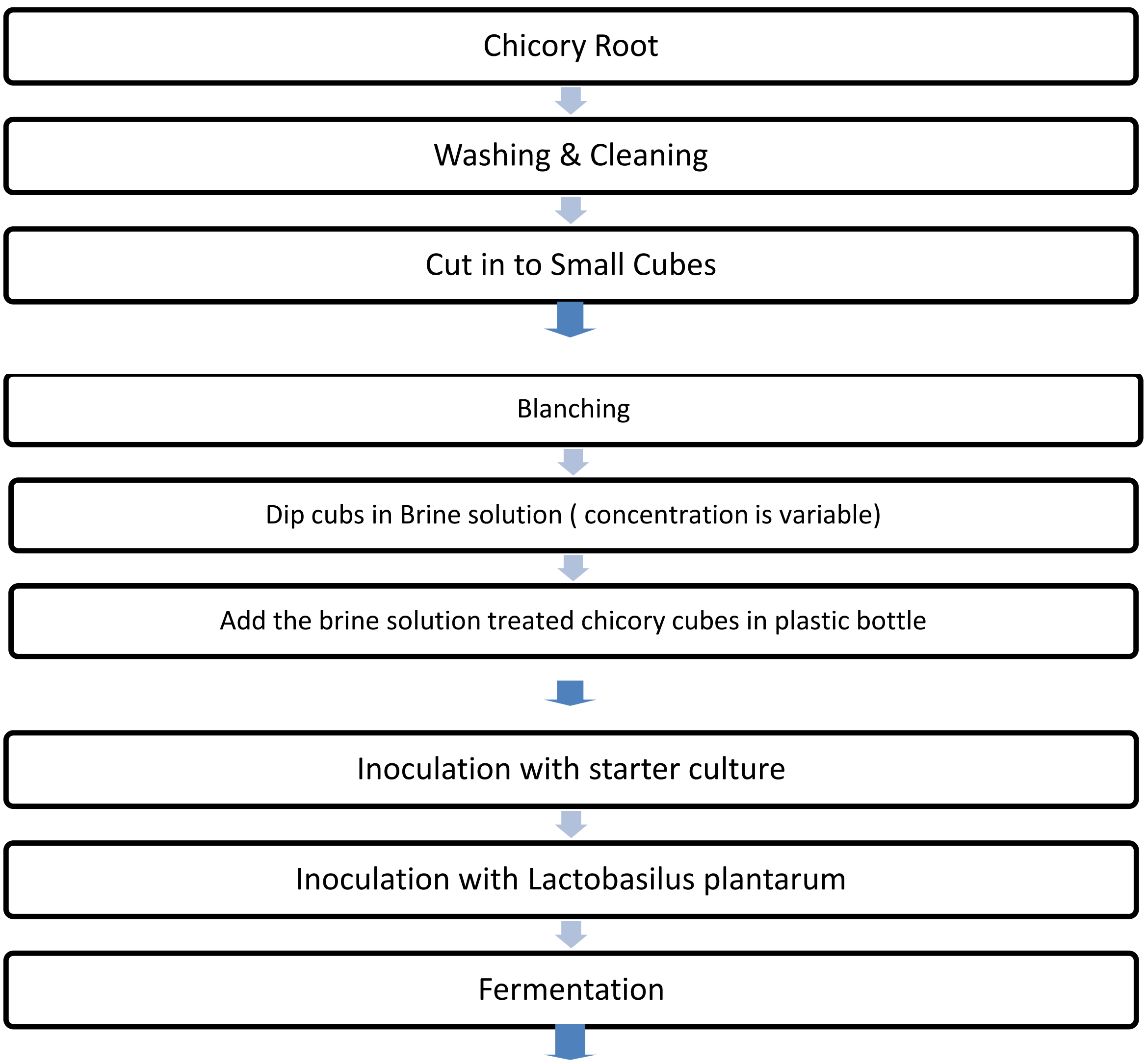
↓

Powder Chicory

Proximate analysis:

- Concentration of pulp
- Loss of Weight during Drying
- Equilibrium moisture content
- Water Activity
- Sugar Concentration
- % of Inulin before & after drying
- Glucose and Fructose
- Moisture determination
- Microbial analysis
- Density
- Sensory Analysis

5.1.3 Objective 3: Preparation of Chicory Pickle as a source of Dietary fiber:



Add Preservative

↓

Final Packing (Glass jar & HDPE bottles)

↓

Chicory Pickle

Proximate analysis:

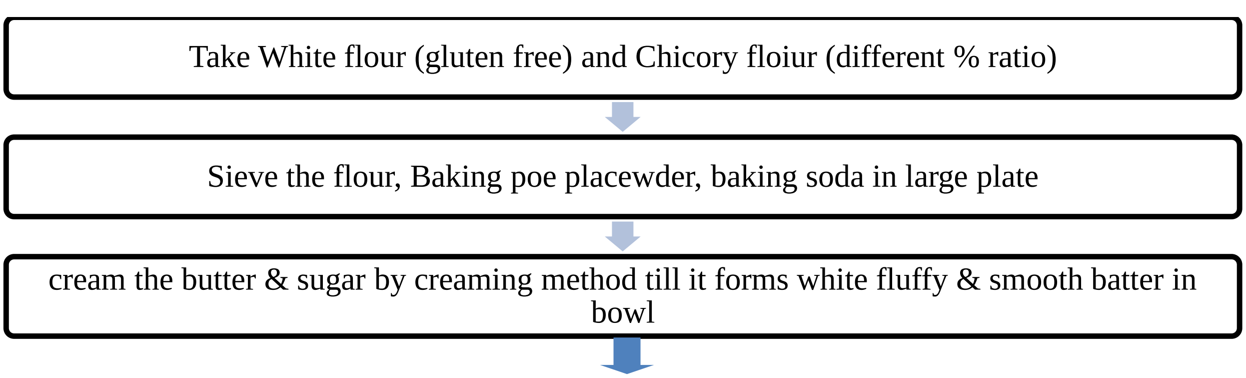
(Taken as a reference for processing and testing -Mohapatra et al.,2017)

- Lactic acid production
- Starch
- Total Sugar
- Crude protein
- Fat
- Shelf Life
- Storage Condition Require
- Sensory (Bitterness)

5.1.4 Objective 4: Preparation of sugar and fat reduced muffins using Chicory Flour:

A control recipe was prepared according to the literature (Hui & Corke, 2006) and slightly modified (Table), where sugar and fat was replaced by Chicory Flour.

Wheat Flour	Sugar	Baking Powder	Salt	Skim milk powder	Oil	Liquid whole egg	Water
115.3	69.2	5.8	1.4	8.7	57.6	34.6	57.6
115.3	65.2	5.8	1.4	8.7	53	34.6	57.6
115.3	60.2	5.8	1.4	8.7	48	34.6	57.6
115.3	55.2	5.8	1.4	8.7	45	34.6	57.6
115.3	51.2	5.8	1.4	8.7	43	34.6	57.6
115.3	46.2	5.8	1.4	8.7	39	34.6	57.6



Add flour & milk alternately in the mixture of butter & sugar

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Add 2-3 drops of vanilla extract

↓

Bake at 180° for 20-30 min until the muffins have risen & are golden brown

↓

Carefully take the muffins out of the tinn and allow to cool on cooling tray

↓

Muffins are ready

↓

Sensory evaluation

Proximate analysis:

A) Sensory Properties (9 Point Hedonic Scale)

B) Physical Analysis

- Diameter
- Thickness
- Density
- Texture profile Analysis
- Nutritional Analysis :
- Ash Content (Ranganna, 2012)
- Moisture Content (Ranganna, 2012)
- Fat Content (Ranganna, 2012)
- Protein Content (Ranganna, 2012)
- Carbohydrates
- Total Starch analysis (AACC,1995).

1) Calcium
2) Phosphorus

3) Iron

6. EXPECTED RESEARCH OUTCOME

1. Developing the products from chicory root which is reach in Inulin as well rich in other phenolic compounds present in chicory

2. Developing the products which can be commercialized on industrial scale.

3. Developing the Fermented product as a source of dietary fiber.

4. Developing the product from chicory which have high nutritional value as well as having good taste, flavor, color, and overall acceptability.

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