LEMONGRASS (CYMBOPOGON CITRATUS): A VALUABLE INGREDIENT FOR FUNCTIONAL FOODS

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Abstract

Functional foods are termed as “food for specified health use”. The term basically originated from Chinese saying “Food and medicine are isogenic”. Functional foods are on main focus due to their health benefits and nontoxic behavior. In addition to their nutritional benefits, functional foods found effective against some health problems due to their antimicrobial, anti-cancerous and anti-inflammatory properties. Large number of functional food products is being developed and have found prominent place in present market such as functional drinks, functional bakery and dairy products. One of the important herb is lemongrass (Cymbopogon citratus) with more than 500 species, wide growing capabilities and unique functional properties, catching usefulness in many of the daily life food commodities. All forms of lemongrass such as leave, stalk, oil, flavor used for having best minerals and antioxidants. A lot of work needed to explore the functional properties of this herb by analyzing in different conditions and utilizing in various food items for human consumption such as functional drinks at community level. The review designed to concise the nutrional and functional importance of lemongrass in addition to functional foods formulated foods from various sources.

1. Introduction:

Functional food: A modified food that claims to improve health or well-being by providing benefit beyond that of the traditional nutrients it contains. Functional foods may include such items as cereals, breads, beverages that are fortified or enriched with some useful food sources such as herbs which provide antioxidants, minerals, vitamins etc. Functional foods found effective against some health problems due to their antimicrobial, anti-cancerous and anti-inflammatory properties, in addition to their nutritional benefits. Large number of functional food products are being developed and have found prominent place in present market such as functional drinks, functional bakery products and functional dairy products (Hanafi et al., 2017; Sheth and Hirdyanic, 2016).

Excess consumption of soft drinks has created serious public health issues during last few decades. Functional drinks generated by the addition of antioxidants, vitamins, probiotic bacteria and some other functional ingredients are found helpful against a number of ailments and bears the potential to replace soft drinks (Lim and Mohamed, 2016; Perera et al., 2016).

Lemongrass has scientific name Cymbopogon citratus and common names are West Indian lemongrass, Sere grass, Lemon grass, Citronnelle, Fever grass, Ce kala, Nche awuta, Ahisia tii, Hhashel laymum, Koriko oyibo. Herb belongs to very large class Andropogan having 500 species and family Germineae. About eight species of Cymbopogon citratus are found in Pakistan. Two varieties of lemongrass Cymbopogon flexuous and C. citratus are reported to give maximum lemon flavor and therefore are typically known as lemongrass in Pakistan (Hassan et al., 2007). Lemongrass is a tall, densely tufted grass with numerous stiff stems arising from short rhizomatous rootstocks reaching up to 120 cm in height with average life of 4 years. Fresh grass yields 0.2-0.4% oil, with an average yield of 50-120 kg oil/ha (FAO, 2007; Sah et al., 2012).

Lemongrass (Cymbopogon citratus) as one of the most useful herb for nutritional as well as functional component of foods. Botanically the word “herb” is used for “herbaceous plant”. Herbs belong to the flowering or leafy green parts of plants that maybe used as fresh or dried. Herbs and spices are
traditionally defined as plants that are used for food, medicine, flavoring or fragrance purposes. However, more recently herbs and spices have been identified as sources of various phytochemicals and minerals (Alok et al., 2014). Phytochemicals of herbs are reported to possess strong antioxidant capacity. Free radicals and other reactive species are considered as important causative factors in the development of chronic diseases such as cancer and cardiovascular disease. The addition of antioxidant spices and herbs to food, play important role against cancer and other degenerative diseases (Henning et al., 2011).

Since ancient times, herbs and spices have been extensively used to enhance or improve the flavor of food and also due to their preservative properties. Several popular herbs and spices are known to have beneficial effects for human health, including digestive stimulant, anti-inflammatory, antimicrobial, antioxidant and anti-carcinogenic activities. The beneficial health impacts of herbs are mostly attributed to polyphenols present in their chemical composition. Moreover, other volatile constituents in herbs and spices (particularly essential oils) can also contribute to plant's biological activity, resulting in benefits for human health (Valdes et al., 2015; Kaefer and Milmer, 2008).

Phytochemicals are plant based secondary metabolites that are non-nutritive and biologically-active compounds. Phytochemicals play different functions in the body including preventing damage due to free radicals as antioxidants and hormones, stimulators for enzymes, antibacterial effect, physical protective actions and reducing the bioavailability of nutrients. Compounds are classified into twelve groups including polyphenols, carotenoids, polysaccharides, lectins, terpenes, alkaloids, glucosinolates, polycyctealens, allium compounds, chlorophyll, capsalcoines and betalins. Examples of phytochemicals include groups of substances such as phytic acid, anthocyanin, polyphenols, lignans, oxalic acid, isoiflavones and some vitamins. Antioxidant substances include phenolic compounds, vitamins A, C and E, anthocyanin, lycopene, lutein, coenzyme Q10, beta-carotene, butylated hydroxyansole, free fatty acids and flavonoids (Manach et al., 2004)

In plant kingdom phenolics are most commonly found antioxidants with almost 8000 phenolic structures ranging from simple molecules such as phenolic acids to highly polymerized substances such as tannins. Useful aspects of phenolics include protection against health problems by pathogens, ultraviolet radiations and predators as well as contribute towards prevention of diseases due to free radicals (Dai and Mumper, 2010). *Cymbopogon citratus* may hold a broad range of free radical scavenging molecules which are rich in antioxidant activity such as nitrogen compounds (amines, alkaloids, betalains); phenolic compounds (flavonoids, phenolic acids, coumarins, lignans, quines, tannins, stilbenes); vitamins (A,C,E); terpenoids, cartenoids and some other endogenous metabolites. Herbs contains higher phenolics than fruits and vegetables. (Cai et al., 2003; Brewer, 2011). *Cymbopogon citratus*is generally used as a flavoring agent and as a medicine to treat digestive disorders such as flatulence, indigestion and acidity. Stalks and leaves are also used as an antispasmodic, hypotensive, anticonvulant, analgesic, antiemetic, antitussive, antirheumatic, antiseptic and in the nervous and gastrointestinal problems in traditional medicine in the world (Shah et al., 2011). Lemongrass tea or “infusion” is used in medicines in many countries. It is prepared with fresh or dried leaves and covers a wide range of indications. A number of studies were conducted on lemongrass to show that it exhibits various biological activities including anticancer activity and antioxidant activity. The plant does not show any hypnotic effect and it is not toxic to test organisms (Negrelle & Gomes, 2007; Aibinu et al, 2007).

Natural antimicrobials are receiving a good deal of attention for a number of micro-organism-control issues. Reducing the need for antibiotics, controlling microbial contamination in food, improving shelf-life extension technologies to eliminate undesirable pathogens and/or delay microbial spoilage, decreasing the development of antibiotic resistance by pathogenic microorganisms or strengthening immune cells in humans are some of the benefits (Fisher and Phillips, 2008).

*Cymbopogon citratus* is ranked as the top antioxidants containing herbal tea consumed around the world. A lot of work is reported on tea and oil of this unique herb but limited work is done onextract for analysis and for utilizing in food products. Not a single study is reported on the use of fresh extracts of *Cymbopogon citratus* in drinks without any heat treatment where antioxidants losses are at minimum level. Literature for different compositional and functional properties was evaluated for *Cymbopogon citratus* in addition to functional foods and then further divided into various segments.

**2. Physicochemical Composition of Lemongrass**

Chemical composition of lemongrass include proximate analysis, mineral analysis and antioxidants determination.

Uraku et al., (2015) collected lemongrass leaf samples from Ebonyi state of Nigeria for the evaluation of proximate components on dry basis. The reported value of proximate in lemongrass leaf were high for protein (22.59 ± 0.01%), fiber (37.53 ± 0.67), moisture...
(11.35 ± 0.01%), carbohydrates (19.64 ± 0.51) and ash (7.15 ± 0.21) but low for fat (2.43 ± 0.04%).

Soares et al., (2013) analyzed lemongrass samples collected from western city of Angola, Benguela. Samples were dried in dark for dried basis analysis of lemongrass. The results of research were moisture 8.52%, protein 19.79%, fat 4.98%, ash 4.11% and total carbohydrates 62.60%.

Aftab et al., (2011) conducted research on lemongrass leaves collected from Punjab province of Pakistan for proximate components analysis. Proximate components revealed the results of moisture, ash, fat, protein, fiber and carbohydrates; 8.52%, 9.40%, 1.25%, 15.68%, 28.78% and 38.44%, respectively. Belewu et al. (2011) reported proximate components of lemongrass leaves samples on dried basis. The reported results of proximate analysis of lemongrass were moisture 12.36%, fat 1.94%, ash 6.13%, fiber 27.72%, protein 15.72% and carbohydrate 29.58%.

Asaolu et al., (2009) evaluated the proximate components present in lemongrass leaves collected from Ekiti state of Nigeria. The results reported on dry basis were moisture 5.76%, ash content 20%, crude protein 4.56%, crude fat 5.10%, crude fiber 9.28% and carbohydrates 55.00%. Food energy of lemongrass was found to be 360.55 cal/100g. Reported factors for the variations in chemical composition of Cymbopogon citratus are plant part used, inherent difference, origin geography, extraction method, maturity stage, soil salinity, water contents in soil and harvesting season (Idrees et al., 2012).

3. Essential Mineral Elements

Uraku et al., (2015) collected lemongrass leaf samples from Ebonyi state of Nigeria for the evaluation of mineral contents. The reported value of minerals (mg/kg) in lemongrass leaf were Zn (0.3 ± 0.01), Cu (3.9 ± 0.1), K (6.4 ± 0.1), Co (3.9 ± 0.1), Fe (1.1 ± 0.2), Ca (21.4 ± 0.2), Na (4.1 ± 0.1) and Mg (25.7 ± 0.4), respectively.

Aftab et al., (2011) collected lemongrass leaves samples from Punjab province of Pakistan for the determination of proximate components. The analysis revealed high contents of K (53.40%), Ca (26.19%) and Si (10.01%) while lower value for Na and Mg were found i.e. 2.57% and 2.05%, respectively.

Asaolu et al., (2009) analyzed the mineral contents in lemongrass leaves collected from Ekiti state of Nigeria. The results revealed that lemongrass leaves were rich in essential mineral elements, while the recorded concentrations of Fe, Zn, Mg, Na, K, Cu, Mn, P and Se were 43, 16, 226, 323, 298, 242, 25, 1245 and 2 mg/kg, respectively; while heavy metals such as Lead (Pb), Cadmium (Cd) and Arsenic (As) were found below the detection limits. The presence of essential mineral elements at high level and the absence of heavy metals made lemongrass a best choice for use in food products.

4. Antioxidant Activity of Lemongrass

Essential oil of lemongrass is reported rich in antimicrobial and antioxidant activity. Both, extract and oil of lemongrass contains a variety of valuable amount of bioactive components like flavonoids, alkaloids, tannins, terpenes, phenolics, anthocyanins, steroids, saponins, isoﬂavones, coumarins, lignin’s, catechin, isocatechins and ascorbic acid (Tavares et al., 2015; Lu et al., 2014).

Adukwu et al., (2016) evaluated the antioxidant activities of three varieties of lemongrass from Cirebon, West Java-Indonesia. Ethanolic extract of C. citratus indigenous variety showed the lowest inhibitory concentration (IC50) of DPPH scavenging activity which was only 2.75 µg/ml while for FRAP capacity (IC50) found lowest 12.22 µg/ml. The ethanolic extract of lemongrass variety Cymbopogon winterianus exhibited the phenolic content at highest level while n-hexane extract revealed the carotenoid content at highest level. Flavonoid content were found highest in ethyl acetate extract of C. citratus.

Uraku et al., (2015) collected lemongrass leaf samples from Ebonyi state of Nigeria for the evaluation of phytochemical contents. The reported vitamin C, B2, B9, A, B1 and E contents (mg/100g) were 2.43 ± 0.06, 2.23 ± 0.06, 0.13 ± 0.02, 1.25 ± 0.02, 2.33 ± 0.04 and 0.91 ± 0.13, respectively. The flavonoids, vitamin C and E contents in the lemongrass leaf extract suggest appreciable anti-oxidant effects of the plant leaves.

Bioneset et al., (2015) reported the antioxidant activity of lemongrass oil by distillation process through microwave. Lemongrass leaves were first sundried and the extraction of oil was performed. Results showed high phytochemicals contents of lemongrass with strong antioxidant capacity (44.06 mg Trolox/ 100ml of EO) and high phenolic content (149.20 GAE/100ml). Lu et al., (2014) collected lemongrass leaves samples from a Malaysian state Selongar for the determination of phytochemical contents. The chloroform extracts of lemongrass showed antioxidants activities, FRAP activity was 0.09 ± 0.002 mmol/g, DPPH assay activity was 1998.10 ± 0.02 µg/mL and β-Carotene Bleaching Assay contents was 0.90 ± 0.02 µg/mL.

Soares et al., (2013) analyzed lemongrass samples collected from western city of Angola, Benguela. Samples were dried in dark for dried basis analysis of lemongrass. The reported phytochemical contents in (mg GAE/100ml) of aqueous, ethanolic and methanolic extracts were; phenolics 28±0.24, 6.11±0.11 and 3.26±0.26, respectively; flavonoids were 5.04±0.15,
6.62±0.65, 3.47±0.49, respectively; tannins were 1.59±0.39, 1.88±0.18, 2.32±0.16, respectively and the ascorbic acid contents were 3.98±0.46, 2.34±0.69, 3.05±0.12, respectively.

Mirghani et al., (2012) collected lemongrass leaves from Kuala Lumpur state of Malaysia for evaluating the antioxidants potential of its oil. The results showed that the phenolic concentration in lemongrass oil was 2100.769 mg/l GAE, DPPH scavenging activity for lemongrass stalk was 89.5% and highest degree of inhibitory activity in anti-diabetic tests was found (89.63%).

Selim, (2011) conducted research on indigenous herb of Egyptian lemongrass for the evaluation of its antioxidants activity. Methnolic extracts were found best in antioxidants activity of all experiments. Results showed that the inhibition of free radicals in DPPH assay were at IC50 of (48.66±3.1 µg/ml).

Asaolu et al., (2009) evaluated the phytochemicals in lemongrass leaves collected from Ekiti state of Nigeria. The concentration in (mg/kg) of Saponins, alkaloids, tannins, phenols, flavonoids, anthraquinones and steroids in ethanolic extracts of lemongrass were 0.645, 0.520, 0.600, 0.400, 0.532, 0.005 and 0.058, respectively. Sacchetti et al., (2004) conducted research in Feerara state of Italy to check the comparative antioxidants activity of oils belonging to eleven different herbs. C. citratus was found most effective in DPPH assay with radical inhibition activity range between 9.6 ± 0.42 – 64.3 ± 0.45 %.

Physical properties of sample, sample preparation, spermine treatment, polarity and type of solvents used in extraction, method of extraction as well as temperature and time of extraction influenced the yield, recovery and phenolics type present in extract. Season, soil composition, climate, along with age, part and growing stage of plant may also affect the phenolic contents of lemongrass (Orabi et al., 2015; Ekpenyong et al., 2014).

5. Anti-microbial Activity of Lemongrass

Microbial contamination in foods results many severe health problems around the world. Many chemical and synthetic types of preservatives are being used which contain hazardous chemicals casing many environmental, health and safety issues. Due to that it needs to explore safe antimicrobial agents by using natural sources like spices, herbs and medicinal plants (Zulfa et al., 2016; Cock and Vuureen, 2015).

Lemongrass extract, infusion and oil tested against many of the important food spoilage and human health problematic microorganisms by several scientists. Lemongrass inhibit the growth of microbes such as B.cereus, Rhodotorula glutinis ATCC 16740, Schizosaccharomyces pombe ATCC 60232, Yarrowia lypolitica ATCC 16617, Porphyromonas gingivalis W50, Aggregatibacter actinomycetemcomitans ATCC43718, L.monoctyogenes , P. anomala, Pseudomonas aeruginosa, Proteus vulgaris, Salmonella paratyphi (Zulfa et al., 2016; Tavares et al., 2015; Osuntokun and Olajubu, 2015; Calo et al., 2015; Chauhan et al., 2015; Balakrishnan et al., 2014). Matiacevich, (2016) conducted research on lemongrass added edible coating for the evaluation of antimicrobial effect of lemongrass oil. Edible coating microcapsules of 22µm size were made containing more than 51% oil present in their nucleus. Results showed that lemongrass oil added films inhibit the growth of both Listeria monocytogenes ISP and Escherichia coli ATCC 25922 at all concentration of 1250 mg/kg, 2500 mg/kg and 5000 mg/kg in liquid culture. Conclusion was made that lemongrass found effective as antimicrobial agent so it may be used in foods and other material against microbial problems. Zulfa et al., (2016) evaluated the antimicrobial effect of methnolic lemongrass extracts on five major foodborn pathogens including Escherichia coli O157:H7, Candida albicans, Kelbsiella pneumonia, Bacillus cereus and Staphylococcus aureus. Results reported that lemongrass extracts showed significant antimicrobial activity against all tested microbes Escherichia coli O157:H7, Candida albicans, Kelbsiella pneumonia, Bacillus cereus and Staphylococcus aureus with zone of inhibition (ZOI) of 7.5mm, 9mm, 11mm, 12mm and 10mm, respectively.

Madeira et al., (2016) conducted research in Sao Luis state of Brazil on the evaluation of lemongrass oil effects on viability of human cell, denture surface and Conidia albicans biofilms. Results showed that the significant (p < 0.05) minimal fungicidal concentration (MFC) and minimal inhibitory concentration (MIC) of lemongrass oil which was required for the inhibition of C. albicans growth were 0.625 mg/mL and 2.5 mg/m, respectively. Furthermore, the presence of lemongrass oil showed reduction of cell counting in biofilm (p < 0.05) thus MIC found sufficient to decrease 90% of cells. Conclusion revealed that lemongrass oil was found effective against Conidia albicans biofilms and posed no lethal effects.

Lee at al., (2016) conducted research on the evaluation of antimicrobial activity of lemongrass oil added functional food coating in Daejeon state of Korea. Films of flaxseed meal protein were prepared for packaging various food items. Results revealed that the film containing only 1% lemongrass oil showed significant (p<0.05) antimicrobial activity after 12 days storage at 4°C against Escherichia coli O157:H7 and Listeria monocytogenes as compared to control treatment.
Selim, (2011) conducted research on unique herb of Egypt lemongrass to evaluate the in vitro antimicrobial activity against Salmonella choleraesuis, Bacillus cereus, S. choleraesuis and yeast conidia species. Results revealed that essential oil of lemongrass exhibited strong antimicrobial activity against all tested bacteria while methanolic extract showed antimicrobial activity at moderate level. Complete inhibition activity against S. choleraesuis and B. cereus was found to 1% at 10min and 5% at 10min, respectively. Essential oil of lemongrass found to be most effective against Salmonella choleraesuis and Bacillus cereus.

Asaolu et al., (2009) evaluated the antimicrobial activity of lemongrass leaves extract collected from Ekiti state of Nigeria. The results of ethanolic extracts of lemongrass reported to have antibacterial activity against Staphylococcus typhi. Ethanol extract was found to be most effective at concentration level of 50mg/ml but was inactive on L. monocytogenes, E. coli and S. aureus. The aqueous extracts of lemongrass has not exhibited any inhibitory activity against tested bacteria.

6. Anti-Inflammatory and Other Health Benefits

Lemongrass (C. citratus) has been extensively used in traditional medicines from long past around the world in many countries due to presence of many therapeutic properties like antifungal, antimicrobial, anti-inflammatory and analgesic (Skaria et al., 2016; Yousef, 2013).

Li et al., (2017) conducted research on the estimation of lemongrass oils effects on oxidative stress, acetaminophen toxicity and drug-metabolizing hepatic enzymes in efficacy study on rats. Results showed the significant (p<0.05) reduction in heptic ethoxyresorufin O-deethylation, testosterone 6b-hydroxylation activities, reactive oxygen sp. levels and lipid peroxidation when rats were treated with 400ml/kg citral or lemongrass oil. Moreover glucostrasyltransferase activity of Uridine 50-diphospho and oxidoreductase activity of NAD (P) H: quinone were significantly (p<0.05) increased by addition of 400mg/Kg lemongrass oil and citral, respectively in rats liver. Both lemongrass oil and citral reported as effective components against tested parameters and safety in use with no deleterious effects.

Han and Parker, (2017) reported the use of lemongrass essential oil against pre-inflamed dermal fibroblasts in human in Utah state of United States of America. Impact of lemongrass oil was tested on seventeen protein biomarkers to evaluate the anti-inflammatory effect of citral component of lemongrass oil. Results revealed that lemongrass oil inhibited inflammatory all tested biomarkers production. Furthermore lemongrass also showed significant (p<0.05) effect on gene expression and lemongrass found effective in use on skin.

Chukwuochaa et al., (2016) conducted research on the estimation of anti-malarial activity of whole leaves of lemongrass in Imo State of Nigeria. Lemongrass extract was prepared and evaluated for anti-malarial activity against Plasmodium berghei ANKA and P. chabaudi. Results showed low dose of whole lemongrass plant exhibited higher antimalarial activity as compared to high dose against P. berghei ANKA. Moreover whole plants extract revealed best antimalarial activity then chloroquine and infusion. Chloroquine and whole lemongrass plant combination showed greater activity than chloroquine alone against patent infection of P. berghei ANKA.

Elhassan et al., (2016) conducted research on three species of Genus Cymbopogon (Family Poaceae) C. nervatus (inflorescences), C. proximus (leaves and inflorescences and Cymbopogon citratus (leaves) for evaluating their anti-tubular activity in Khartoum state of Sudan. Research was made on clinical isolate considering the need of time because the fact that tuberculosis cause mortality second to the human immunodeficiency virus (HIV). Results showed that all species of lemongrass exhibited effective anti-tubercular activity up to 15µl/ml concentration of oils. Uraku et al., (2015) reported lemongrass as good antimalarial effect when phytochemical screening of different plants Ocimum basilicum, Spilanthes uligionsa, Hyptis spicigera and Cymbopogon citratus leaf extract was performed on malarial parasite infected mice checking the hematological changes. The results revealed higher antimalarial effect of lemongrass as compared to others.

Wang et al., (2014) conducted research on oil of lemongrass leaves for the evaluation of various health effects in an efficacy study. Results showed lemongrass oil effective as a sudorific, stimulant, ant-catarrhal and antiperiodic. Furthermore oil revealed the analgesic, depressant, antipyretic, antimicrobial and antibacterial properties.

Ademuyiwa et al., (2014) conducted research on the evaluation of effects of lemongrass extracts on the lipid profiles, hormonal profile and blood sugar level of normal albino rats. Results showed that both ethanolic and aqueous extracts of C. citratus caused significant (p<0.05) reduction in glucose level of blood and enhance hormones (T3, TSH and T4), high density protein, triglycerides, total cholesterol when supplied orally at the dose of 200mg/kg to albino rats for 3o days.

Wright et al., (2009) conducted research in Gauteng state of South Africa on Cymbopogon citratus infusions on patients of HIV/AIDS to evaluate the effectiveness of this unique herb against HIV/AIDS.
Lemongrass extract was compared with control group provided with 0.5% gentian violet aqueous solution. Results showed that the C. citratus juice found effective significantly (0.02) than gentian violet aqueous solution in oral thrush treatment as a remedy in HIV/AIDS patients.

6. Functional Foods

Hanafi et al., (2017) collected samples of mangosteen peel from local market of Bogor state of Indonesia for the formulation of functional drink with the addition of gelatine. Functional drink was prepared by the addition of anthocyanin rich extract of mangosteen and gelatine. Results showed higher values of antioxidant activity (78%) and low level of total microbes (2.6%log) on second day of storage. Higher antioxidants potential suggested the beneficial effect of functional drink against cancer and other degenerative diseases.

Dimitrovski et al., (2016) conducted research on the development of functional drink from artichoke juice in Skopje capital city of republic of Macedonia. The functional product was made by the addition of Lactobacillus plantarum PCS26 probiotic strain in artichoke juice as a functional ingredient for the fermentation process to enhance the functional benefits. Results showed the reduction in pH level from 6.5 to 4.6 and enhancement in fructose contents in fermented functional drink. Moreover lactic acid also produced in concentration of 4.6g/L in addition to identification of acetic acid and succinic acid. Functional ingredient showed shelf life of functional product also increased to 35.7±6.4 days as compared to pure artichoke juice 19.70±0.50 days.

Morato et al., (2015) conducted research on the development of omega-3 added chocolate milk based functional drink in Sao Paulo state of Brazil. The results showed that 15 days consumption of functional drink in exhausted rats decreased their muscle damage (lactate dehydrogenase −18.7% and creatine kinase −20%). Furthermore functional drink also increased the activity of major endogenous enzymes (catalase +41%, glutathione peroxidase +35.7% and superoxide dismutase +26.7%) as well as decreased the total triacylglycerols (−16.2% and cholesterol (−7.8%). Conclusion was made that functional drink was resulted to minimize the deleterious effects of extensive exercise.

Raiesi et al., (2013) conducted research on the utilization of rice bran in the formulation of functional drink. Rice bran was used as functional ingredient considering the presence of high nutritional components like carbohydrates, oil, proteins, phenolic compounds, lignin, vitamins and enzymes. Results revealed that the addition of rice bran in orange juice exhibited the enhancement of antioxidants activity and vitamin contents significantly (0.05) that may impart significant role against degenerative diseases.

Ahmad et al., (2013) conducted research on the formulation of functional drinks in Faisalabad, Punjab province of Pakistan. Epigallocatechins gallate (EGCG) and Catechins were added in green tea at concentration of 550mg/500ml for the enhancement of functional properties of prepared functional drinks. Results indicated by both sensory evaluation and efficacy trials were highly appreciable as functional beverages upgraded serum antioxidant activity of rats.

Lee et al., (2013) conducted research in Tucuman state of Argentina on functional drink development. Functional drink was formulated by the addition of cobalamin producer lactobacilli in already prepared soymilk; a combination of soya bean and milk. The functional product was practiced on pregnant mice for efficacy studies. Results revealed that the lactobacilli added soymilk prevented the development of all symptoms due to the deficiency of vitamin B12 in both female mice and their offspring thus playing key role as a functional ingredient.

Mestry et al., (2011) collected carrot and watermelon from local market of Indian city Mumbai for the preparation of functional product. Functional drink was comprised of Lactobacillus acidophilus in addition to watermelon and carrot. Results revealed that the addition of Lactobacillus acidophilus first increased the total viable count from 8.69log (CFU=mL) to 9.23log (CFU=mL) then decreased rapidly thus made product safe from microbial load at final stage. Furthermore fermentation also enhanced the protein content 14.18 mg/mL and decreased reducing sugar from 33.7 to 0.41 mg/mL. Functional effects of Lactobacillus acidophilus made it functional ingredients in conclusion and product as functional drink.

Erda, (2011) conducted research on the formulation of functional product from leaf powder of Centella asiatica. Results showed remarkable nutritional value of prepared functional product with chemical composition; water 3.68%, fat 2.10%, protein 13.00%, asiacid 0.66%, vitamin C 216.16mg/100g, beta-carotene 330ppm, Fe 14.29mg/100g, calcium 276.63mg/100g and selenium 52.02mg/100g. Higher levels of vitamin C and calcium may suggest the functional role of developed product against scurvy, osteoporosis and hypocalcemia. Luo et al., (2009) reported the use of hawthorn and Auricularia auricular in the preparation of functional food in Beijing city of China. Results showed that functional diet may exhibit novel health benefits by lowering Low Density Lipoprotein (LDL) and increasing free radical scavenging effects. Moreover the efficacy study on
mice indicated the reduction in total serum cholesterol, atherogenic index and enhanced antioxidant potential. Perera et al., (2008) reported the formulation for functional drink by using barley extracts in Gifu state of Japan. Water extract of barley was used in the formulation of functional drink considering the stability of barley antioxidant activity at higher temperature. Results showed that extraction at 205°C showed maximum antioxidants potential (>90%) in peroxy nitrite assay. Functional drink also revealed to possessed amino acids in addition to antioxidant activity for its functional role in the living body Sinha et al., (2007) conducted research on the exploitation of whey protein concentrate (WPC) as functional food and also formulated functional drink in Mysore state of India. Results exposed that the WPC protein content was 75.6% and a little reduction on the treatment with enzyme (69.6%). Additionally water absorption capacity was found 10 ml/100 g that improved in samples of enzyme treatment from 16 to 34 ml/100 g. The emulsion capacity of enzyme treated samples indicated a decreasing trend and amino acid outline presented higher level of methionine. Prepared beverage possessed 52% crude protein, 6.6% ash and 10% crude fat with functional properties of above mentioned WPC benefits.

Reyner and Horne, (2002) conducted research in Leicestershire state of United Kingdom on the evaluation of functional drink against sleepiness in human based efficacy study. Considering the fact that drivers mostly face road accidents due to their sleepiness, functional drink was prepared with taurine, glucuronolactone and caffeine as functional ingredients. Results showed that the functional drink noticeably reduced sleep induction and low sleepiness effect when tested by electroencephalogram as compared to control drink which was prepared without taurine, glucuronolactone and caffeine when continuous driving performed for 14 and 17 hours. Conclusion include the recommendation of prepared drink for drivers and workers to avoid from sleepiness accidents.

7. Conclusion:

Lemongrass found as one of the most useful herb with multi-nutritional as well as functional properties. Emphases should be taken on the use of such a unique herb for various food and pharmaceutical purposes by which the community can get benefits.

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