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A Study on Antioxidant, Phytochemical and Fatty acid Composition of a Local Breakfast Item of Assam, India Fortified with Spice and Herb

Author: Priyakshi Borkotoky[1]

Co Authors: Bishnu Prasad Sarma[2]

[1]Faculty of Allied Health Sciences, Srimanta Sankaradeva University of Health Sciences, Guwahati, Assam, India
[2]Department of Kayachikitsa, Govt. Ayurvedic College, Guwahati, Assam, India

ABSTRACT

India has experienced a transformation in public health nutrition scenario in last few decades along with alteration in agricultural field and lifestyle. Non Communicable Disease (NCD) has developed into a public health issue and was accountable for 61.8% death in India in 2016. Several epidemiological studies have recognized the link between free radicals produced due to oxidative stress and NCDs. Antioxidants as well as phytochemicals are compounds in foods that neutralize free radicals. More over the polyunsaturated fatty acid (PUFA) is proved to decline the level of inflammatory and reactive oxygen species. To produce a healthy, economic, palatable and easily available mix to combat NCD, value addition to a locally available breakfast cereal item known as Sandoh was done with herb and spices as these are loaded with antioxidants and phytochemicals. The nutritive value analysis of the fortified mix reveals that it contains antioxidants like, vitamin A (29.8 IU), vitamin E (0.57 mg), vitamin C (0.16 mg), selenium (11.2 mcg), copper (193.4 mcg), zinc (529.2 mcg), iron (2531 mcg) and manganese (810.7 mcg)along with phytochemicals, such as alkaloids, saponin, terpinoids, cardiac glycosides and phenols, but limited in flavonoids and tannins. Major Fatty acids present in the health mix are palmitic acid, stearic acid, oleic acid, eicosenoic acid and lenoleic acid. The clinical study verifies it as a better breakfast alternative than *Sandoh guri with* protective and preventive dietary supplement against NCD.

Key Words *Antioxidant, Phytochemical, Fatty acid, Herbs, Non Communicable Disease*

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INTRODUCTION

Establishment of good health and wellbeing for all is an essential agenda of Sustainable Development by 2030. Non Communicable Diseases (NCD) is an area of concern for overall health and wellbeing of individuals in present time and arises as a public health issue. Presently the Indian government health policy is persuading with this changing health scenario of disease transition and burden. NCD alone was accountable for 61.8% death in India in 2016[(1)]. So, considering the need for public health intervention in the field of NCD, the Government of India had strengthened the "National

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Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS)" through the Ayushman Bharat Pradhan Mantri Jan Arogya Yojana scheme in 2018. The ICMR[2] *India: Health of the Nation's States — The India State-Level Disease Burden Initiative* report highlighted that the dietary risks, high systolic blood pressure, high fasting plasma glucose, high total cholesterol, high body-mass index, and impaired kidney function were the major causes of disability-adjusted life-years (DALYs) in high epidemiological transition level (ETL) state of India[1].

Diet is a amendable cause of NCD and from systemic review of different publications, both scientific and non-scientific a holistic, natural, wholesome and pre-emptive move of people is noticed toward wellness and healthcare. For this reason nutrition counseling, identification and awareness on locally available food items with NCD preventive properties, fortification of locally available food items with herbs rich in antioxidant and photochemical etc may be good initiates to prevent NCD at a large scale. This will ensure suitability as well as products will be locally available and processing is simple. Following this idea, in the present study a local breaksfast item of Assam commonly known as *Sandoh guri* (roasted parboiled rice powder) was fortified with herbs and pulse in a natural way[3]. Presently, a much renewed interest is observed in use of alternative medicines. Herbs and spices are easily available, safe, less expensive, efficient, and rarely have side effects that could be the best source to obtain varieties of products with health benefits. Today the pendulum has moving reverse and scientific finds are showing that the spice basket can be use as a powerful medicinal stock. *Arjuna (Terminalia arjuna), cinnamon* (*Cinnamomum verum)* and *fenugreek (Trigonella foenum- graecum)* are herbs and spices scientifically known be used for different NCDs in ayurveda. In view of the medicinal uses of spices and herbs, value addition of these herb and spices is done to *Sandoh guri* by fortifying it with to add dietary factors like antioxidants, phytochemicals, dietary fibres etc. To maintain the protein content *green gram dal (Vigna radiate*) is also added to the mix[3]. As amount and quality of antioxidants and fatty acids are determinants of efficacy of the product, the objective of the paper is to evaluate the occurrence of antioxidants, phytochemicals and type fatty acid in the fortified *Sandoh.*

MATERIALS AND METHODS

Sample collection and processing:

Sandoh is a popular cereal based breakfast item of Assam. As a cereal- pulse combination it has better nutritive value than cereal or pulse alone. *Sandoh* is fortified with green gram *dal*. Individually cereals and pulses are lacking in lysine and methionine respectively, but in combination both complement each other. It is a relatively cheap combination, but balance and well-off source of energy, protein, carbohydrates,

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invisible fat, dietary fibre, vitamins and minerals. Moreover, due to low moisture content, during the storage cereals and pulses are comparatively secure and processing is also easy. To enhance the nutritive value parboiled rice is used. Recent studies reveal that fenugreek, arjuna and cinnamon have good hypolipidemic properties. These products also help in improving the keeping quality of any food product. So supplement the hypolipidemic effect in the prepared mix fenugreek, arjuna and cinnamon are added to it. The ratio of powered ingredients in the mix is as - parboiled rice, green gram *dal*, arjuna, cinnamon and fenugreek are mixed together in proportion of 70:30:2:2:2. Basic food processing and preservation techniques used are mentioned below

✓ Cleaning: To remove all foreign matters like stone, hey etc.

✓ Washing: To clean ingredients all dust, sand etc.

✓ Sun drying: To reduce extra moisture and make ingredients dry.

✓ Roasting: To maintain the moisture level below 12 per cent to avoid microbial contamination. It is also done to develop palatable flavours.

✓ Grinding: To make all ingredients into powder form.

✓ Mixing: All ingredients are mixed in correct proportions.

Estimation of Vitamins (A, E & C) & Minerals (Se, Cu, Zn, Me & Fe)

Data on standard values of vitamins (A, E and C) and minerals (selenium, copper, zinc, iron and manganese) content per 100 grams of each ingredients of the mix are referred and a complied table is prepared for calculation of these nutrients in 100 g of the mix (Table 1)[4,5,6,7,8,9].

Table 1 Vitamin and mineral content of ingredients per 100 g mix[4,5,6,7,8,9]

Ingredients	Parboiled rice	Green gram *dal*	Cinnamon	Fenugreek	Arjuna
Vitanim A(mg)	0	81.7	295	60	0
Vitanim E (mg)	0.73	0.1	2.5	0.8	0
Vitanim C (mg)	0	0	3.8	3	1.47
Selenium (mcg)	14.35	0.348	3.1	6.3	78
Copper (mg)	0.164	0.116	0.38	1.1	1.29
Zinc (mg)	0.542	0.232	1.9	2.5	1.2
Iron (mg)	0.35	5.22	8.3	33.5	1.82
Manganese (mg)	0.455	0.116	17.5	1.2	6.6

Phytochemical Analysis

Sample of the product was analysed at Indian Institute of Crop Processing Technology, Thanjavur, India for phytochemical[10].

Fatty Acid Analysis

Sample of the product was analysed at SGS India Private Limited, Gurgaon, India for fatty acid according to AOCA method.

RESULTS AND DISCUSSION

Antioxidants

Oxidative stress is a notable physiological condition in NCD. By improving the antioxidant

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status of the body, oxidative stress as well as disease conditions can be prevented and controled. Some nutrients like vitamin A, vitamin C, vitamin E, selenium, copper, zinc, iron and manganese are considerable antioxidants which have beneficial impact on NCD. Estimation of these nutrients is presented in Table 2.

Table 2 Vitamins & minerals with antioxidants present in per 100g mix

Nutrient	Antioxidant	Amount
Vitamins with antioxidant properties	Vitamin A	29.8 IU
	Vitamin C	0.16 mg
	Vitamin E	0.57 mg
Minerals with antioxidant properties	Selenium	11.2 mcg
	Copper	193.4 mcg
	Zinc	529.2 mcg
	Iron	2531 mcg
	Manganese	810.7 mcg

The antioxidants present in the developed mix were found as vitamin A (29.8 IU), vitamin E (0.57 mg), vitamin C (0.16 mg), selenium (11.2 mcg), copper (193.4 mcg), zinc (529.2 mcg), iron (2531 mcg) and manganese (810.7 mcg). These nutrient components are significant element with antioxidant property in an animal diet and have great impact on animal health and immunity. Certain nutrients serve as antioxidants or /are components of antioxidant enzymes. Antioxidants include vitamins C and E, carotenoids and antioxidant enzymes containing selenium, copper, zinc, iron and manganese. For human or animal health, antioxidant is important as it neutralizes the harmful free radicals produced during different cellular activities and stress conditions. Optimal levels of selenium, copper, zinc, iron and manganese are responsible for maintaining the most favorable levels of endogenous antioxidants in the body tissues and food antioxidants are best absorbed and metabolized in presence of provision of optimum nutrient supply.

Vitamin A and E are hydrophilic antioxidants and can protect cell membrane peroxidation, while vitamin C is a water-soluble antioxidant and reacts with oxidants in the cell cytosol and the blood plasma. Vitamin E is a chain-breaking antioxidant that counteracts with free radicals and prevents oxidation of lipids in membranes [(11)]. The vitamin E prevents peroxidation of phospholipids as the potent defender inside the body. It is established that vitamin E reduces LDL cholesterol level[(12)]. Beta carotene, the precursor of vitamin A can function as effective radical-trapping antioxidants. Carotenoids functions in synergy with vitamin E. Rather than alone, the combined antioxidants like carotenoids and other antioxidants provide improved antioxidant protection in the aqueous biological membrane setting. Carotenoids promptly prevent lipid peroxidation caused by O_2, through interrupting the chain of reaction of the lipid peroxidation. One molecule of β-carotene is able to stop free radical action by satisfying 1000 molecules of O_2. Among all caritenoids the β-carotene is the main antioxidant, but others like lutein, lycopene and zeaxanthin have strong antioxidant property too. Vitamin C has the ability to eliminate the pyroxyl radicals and also to prevent lipid peroxidation damage in the biomembranes, which makes it the most valued

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antioxidant in the extracellular fluids. Vitamin C is a strong antioxidant as it offers up electrons to ensure stability to reactive species such as reactive oxygen species (ROS) easily and contributes to radical scavenging locating in the cell aqueous phase.

As discussed earlier, selenium, iron, copper, zinc and manganese play important roles with body's antioxidant enzymes and protect body compounds from peroxidation. As a fraction of the enzyme glutathione peroxidase, selenium is important for converting reduced glutathione to oxidized glutathione that destroys peroxides by changing them to risk-free alcohols. This alteration of peroxides stops them from reacting with the lipid membrane and helps in preserving membrane integrity. Selenium works with vitamin E. Selenium is also essential for enhancement of the acquired immune system. It is established that selenium-enriched garlic helps in improving the blood lipid level and peroxidative status. Zinc is an antioxidant with protective effects on coronary artery disease and cardiomyopathy. Details of antioxidant activity of vitamin and minerals are mentioned in Table 3.

Table 3 Vitamins and minerals in antioxidant systems

Antioxidant	Location in cell	Function
Vitamin C	Ascorbic acid (cytosol)	Reacts with several types of reactive oxygen species (ROS) and reactive nitrogen species (RNS)
Vitamin E	α-tocopherol (membranes)	Breaks fatty acid peroxidation chain reactions
β-carotene	β-carotene (membranes)	Prevents initiation of fatty acids peroxidation chain reaction
Selenium	Glutathione peroxidase (cytosol)	An enzyme that converts hydrogen peroxide to water molecule
Copper and zinc	Superoxide dismutase (cytosol)	An enzyme that converts superoxide to hydrogen peroxide
Manganese and zinc	Superoxide dismutase (mitochondria)	An enzyme that converts superoxide to hydrogen peroxide
Copper	Ceruloplasmin (water phase)	An antioxidant protein, may prevent copper and iron from participating in oxidation reactions
Iron	Catalase (cytosol)	An enzyme (primarily in liver) that converts hydrogen peroxide to water

Mechanisms of Antioxidant Functions [13]

Antioxidants are effective via various mechanisms including:

1. Preventive antioxidants: The role of the antioxidants is to hold back formation of free radicals. Best examples are antioxidant enzyme glutathione peroxidase (Se containing) and catalase (Fe containing) that decompose hydrogen peroxide to prevent production of oxygen radicals.

2. Free radical scavengers: They donate of electron to the 'reactive' species to shrink instability and form a more stable radical through oxidation. In this process, the α-tocopherol (vitamin E) scavenges peroxyl radicals to convert it to a tocopherol radical. By donating an electron, the ascorbic acid produces an ascorbate radical that reactivates the vitamin E.

3. Sequestration of metal by chelation: Trace minerals like Fe and Cu are important nutrient

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and pro-oxidants (promote free radical formation) in diet that could propagate the development of more reactive radicals. Hench, they are attached to transport proteins, such as transferrin or ceruloplasmin**,** making them unavailable as pro-oxidants.

4. Quenching of active oxygen species: These antioxidants can translate active oxygen species to more stable forms. Less reactive hydrogen peroxide may be produce from carotenoids and vitamin E in this process. A comparative nutritive value analysis of *Sandoh* and the fortified mix is present in the Table 4, which shows improvement in overall antioxidant content of the new mix.

Table 4 Comparison of antioxidant component in fortified mix & *Sandoh*

Nutrients	Fortified mix/ 100 g	*Sandoh guri* /100 g	↑/↓ in health mix	Type of change from hypolipidemic point of view
Vitamin A (IU)	29.8	0	↑	positive
Vitamin C (mg)	0.16	0	↑	positive
Vitamin E(mg)	0.57	0.73	↓	negative
Selenium (mg)	11.2	14.35	↓	negative
Copper (mg)	0.193	0.164	↑	positive
Zinc (mg)	0.529	0.542	↓	negative
Iron (mg)	2.53	0.35	↑	positive
Manganese (mg)	0.811	0.455	↑	positive

Phytochemicals

WHO[14] emphasizes inclusion of fruits and vegetables to the diet to cut the threat of developing NCD mainly due to presence of phytochemicals in them such as plant sterols, flavonoids and other antioxidants. These nutrient components might be important in modulating cholesterol and other biological processes and have the ability to minimize the risk of atherosclerosis. The result of phytochemical study of the mix is presented in Table 5. From the table it is obvious that the heath mix contains alkaloids, saponin, terpinoids, cardiac glycosides and phenols, but limited in flavonoids and tannins.

Vegetable proteins are hypocholesterolemic and animal proteins are hypercholesterolemic, due to presence of phyto nutrients in vegetable proteins[15].

Table 5 Presence of different phytochemical of the mix

Sl. No.	Phytochemical	Result
1	Tannins	Absent
2	Saponin	Present
3	Flavonoids	Absent
4	Alkaloids	Present
5	Terpinoids	Present
6	Cardiac Glycosides	Present
7	Phenols	Present

Different plant based sample extracts are reported to possess antihyperglycemic[16, 17] , anti-obesity, anti-hyperlipidemic[18] ,anti-inflammatory and antioxidant[19] activities. Several secondary metabolite compounds that are present in plant protects the plant from the non-stop attack of pathogens, insect pests and environmental stresses. These metabolites are called phytochemicals that includes alkaloids,

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cyanogenic glycosides, glucosinolates, flavanoids, saponins, steroids and terpenoids. As a non-nutritive plant chemical, phytochemicals poses protective or disease preventive properties against both plant and humans diseases.

Alkaloids are nitrogen containing low molecular weight organic compounds mostly produce from amino acids in plants. Alkaloid word represents as alkali like or vegetable alkali. Alkaloid in small dose has therapeutic effect, but if it is taken in large dose, it may result in toxaemia. The crude alkaloid fraction is found as the chief antihyperglycemic, anti-inflammatory and antioxidant agent[19]. Oral treatments with *Hunteria umbellate* seed (25 and 50 mg/kg/day) alkaloid fraction shows significant (P<0.05 and P<0.001) decline in the serum triglyceride, total cholesterol and low density lipoprotein cholesterol and increased the serum high density lipoprotein cholesterol fraction (P<0.001) in rats. Adeneye and Crooks[20] suggest that fenugreek alkaloid is able to reduce the increased blood glucose level and lipid profile to almost normal in diabetic rats and suppresses the oxidative stress by reversing liver and kidney pathology caused by diabetes to normal pattern. The study states that diabetic rats receiving 50mg/kg body weight fenugreek alkaloids orally shows significant reduction on serum total cholesterol from 140.33±3.2 mg/dl to 107.83±2.2 mg/dl, triglycerides from 154.33±6.7 mg/dl to 111.83±3.3 mg/dl, LDL from 54.0±2.7 mg/dl to 44.5±1.9 mg/dl and an increase in HDL from 35.7±1.38 mg/dl to 47.16 ±2.1 mg/dl (P<0.05)[21,22]. The hypolipidemic ability of fenugreek alkaloids on blood serum lipids including total lipids, triglycerides and total cholesterol have been reported previously in several studies Fenugreek alkaloid stimulates the hepatic lipogenic enzymes[23] and has significant antioxidant activity.

Saponins are glucosides that are formed by a polycyclic aglycones connected to one or more sugar side chains. Certain beneficial effect of saponins includes lowering of plasma cholesterol levels in humans, anticarcinogenic activity, antioxidant activity of saponins and protective effect on liver injury. Saponins prevent reabsorption of cholesterol by binding blood Cholesterol with bile salt in the intestinal tract[24, 25, 26] . Different ecological studies support the similar effect of dietary saponins in humans[27] . Saponins also seem to help body's immune system and to protect against viruses and bacteria. The non-sugar part of saponins have other benefits, such as reduced risk of cancer and heart diseases due to its direct antioxidant acitivity. Lagume plants are the major source of Saponins as a naturally occurring compound [28]. It is confirmed that saponins stabilize food consumption and lessen plasma cholesterol levels in rats[29]. Major saponins in arjuna bark are arjunic acid, arjunolic acid, arjungenin, arjun glycosides[30]. Saponins are beneficial for improving hyperlipidemia and hyperglycemia.

Terpenoids (also called "isoprenoids") are conventionally utilized for therapeutic purpose in India and China. These are secondary metabolites

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present typically in plants and classified into quite a few categories like monoterpenes (*e.g.* carvone, geraniol, *d*-limonene and perillyl alcohol), diterpenes (*e.g.* retinol and *trans*-retinoic acid), triterpenes [*e.g.* betulinic acid (BA), lupeol, oleanic acid and ursolic acid (UA)], and tetraterpenes (*e.g.* α-carotene, β-carotene, lutein and lycopene). Terpenoids are proved to be helpful in the prevention of several diseases, such as cancer along with its antimicrobial, antifungal, antiparasitic, antiviral, anti-allergenic, antispasmodic, antihyperglycemic, antiinflammatory, and immunomodulatory properties[31, 32, 33]. Terpenoids are responsible for the scent of eucalyptus; flavors of cinnamon, cloves and ginger. But, there is no evidence of association between terpinoids and blood lipid levels. Cardiac glycosides have significant effects on blood pressure which only appear during overnight sleep and it is used for treatment of patient of cardiac failure.

Phenols are known for its utility in nutrient uptake, protein synthesis, enzyme activity and allelopathy. Phenolics show antimicrobial activity antiviral, anti-inflammatory and cytotoxic activity, antimutagenic and anticarcinogenic activities[34,35,36]. It is evident that the therapeutic herbs that are rich in phenolic compounds and bioflavonoids have exceptional antioxidant properties[37]. Different health benefits of Polyphenols are reported, such as elimination of free radical, production and restoration of dietary antioxidants like vitamin E. Though the direct effect of phenol on blood lipid level is palpable, but as mentioned earlier it has important role in maintenance of body's anti oxidant balance, nutrient intake and enzyme activity and hence it has indirect effect on lipid levels. So, in the developed mix alkaloid, saponin and phenol are the main phytochemicals having lipid lowering or antioxidant effect on blood plasma.

Fatty acids

Fat is an indispensable component of a healthy balanced diet and necessary for supply of essential fatty acids and fat soluble vitamins. But the scientific evidence is clear that the amount intake and its quality are important factors in human blood lipid management. Considering this point the fatty acid content in the mix is studied and presented in Table 6.

Table 6 List and amount of fatty acids in the mix

Name of the fatty acid	Percentage
Saturated	**0.30%**
Palmitic acid	0.23%
Stearic acid	0.07%
Monounsaturated	**0.41%**
Oleic acid	0.24%
Eicosenoic acid	0.17%
Polyunsaturated	**0.44%**
Lenoleic acid	0.44%
Values of all other fatty acids and trans fatty acid	<0.01%

The mix contains 0.3% saturated fatty acid made of 0.23% palmitic acid and 0.07% stearic acid followed by 0.41% mono unsaturated fatty acids (0.24% oleic acid and 0.17% eicosenoic acid) and 0.44% poly unsaturated fatty acid (lenoleic acid). Fatty acids (FA) are major components of the human diet that supply energy and a component of cell membranes. Different dietary fatty acids

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have different effect on lipid and lipoprotein concentrations in plasma. Lauric, myristic and palmitic acids are known to elevate both low-density-lipoprotein (LDL) and high-density-lipoprotein (HDL) cholesterol whereas stearic acid has little effect on lipid levels. Oleic and linoleic acids are responsible for increasing HDL level and slightly lowering LDL level. Trans fattyacids lower the HDL, and raise LDL and lipoprotein. Fatty acids in fish oil are known to lower triglycerides with variable effects on LDL. Next to butter and palm oil the palm-kernel and coconut oil are known to have the most hypercholesterolemic effect. For lowering LDL level, substitution of solid fats affluent in lauric, myristic or palmitic acids or trans fatty acids is advisable by liquid unsaturated oils helps in lower LDL. In humans, high-oil diet could lead to obesity and other inauspicious effect on blood lipid levels. Major fatty acids present in the mix are palmitic acid, stearic acid, oleic acid, eicosenoic acid and lenoleic acid.

The key saturated fatty acids present in the mix are palmitic and stearic acid. Intake of the long-chain saturated fatty acids stearic and palmitic acids have relatively lower lipemic response than unsaturated fatty acids because the saturated fatty acids were absorbed less and at a lower rate[(38)]. In combination with trans fatty acids, palmitic acid raises LDL and decreases HDL cholesterol levels. The cholesterol raising potential of palmitic acid is dependent on the linoleic acid level in the diet [(39)]. Naturally palmitic acid is all the time found with other healthy fatty acids in olive, palm and coconut oils. So, in this case the negative impact of palmitic acid on health may be over-estimated [(40)]. Study [(41)] supports that the diets prosperous in stearic acid do not contribute to an increase in classical CVD risk factors and can actually be associated with cholesterol lowering. Normally stearic acid is identified to have a impartial effect on total and low density lipoprotein cholesterol levels in blood [(42, 43, 44, 45)].

Major monounsaturated fatty acids present in the mix are oleic acid and eicosenoic acid. High concentrations of oleic acid can lower blood cholesterol levels and the risk of heart problems[(46, 47)], but the human body can produce a limited amount of it [(48)]. As the human body produces limited amount of oleic acid, human diet should contain oleic acid. Tholstrup and group[(39)] compared the high intake of medium chain fatty acid intake with oleic sunflower oil resulted in 11% lower plasma total cholesterol, 12% lower LDL cholesterol, 32% lower VLDL cholesterol and 22% lower plasma total triglyceride. Oleic acid consumption beneficially affects the serum total lipid and triglyceride. So oleic acid has defensive property against cardiovascular problems in diabetic patients [(49)]. The mix is an excellent source of oleic acid which may be used for maintenance of blood lipid profile. The biological function of eicosenoic acid is not well defined till date. The chief natural source is cord liver oil.

Linoleic acid is the most important polyunsaturated fatty acid present in the mix. Linoleic acid seems to have negative relationship

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with blood LDL cholesterol concentrations, while this relationship is positive for HDL cholesterol concentrations[50]. The proposed hypolipidemic mechanisms of linoleic acid include

1. Decreased cholesterol absorption.
2. Increased excretion of neutral and acidic steroids.
3. Decreased cholesterol synthesis.
4. Transfer of cholesterol from plasma to tissues.
5. Changes in the cholesterol-to-protein ration in LDL.
6. Changes in the rates of synthesis or catabolism of individual lipoproteins.

So in the developed mix, linoleic acid is the most beneficial fatty acid followed by oleic acid which has hypolipidemic property. The palmitic acid is expected to show advantageous effect in presence of linoleic acid and oleic acid.

Efficacy of the mix has been tested on a patient visited to the state Ayurvedic hospital OPD and result shows positive effect on blood lipid profile of the subject. It is found that the mix helps to minimize a range of risk factors of Cardio Vascular Diseases, such as hyperlipidemia, atherosclerosis-index, body weight, body mass index and waist hip ratio[51]. The mix is nutritionally balanced and provides a extensive range of essential nutrients. To examine the usefulness of the mix furthermore, an animal experiment was carried out and significant reduction in triglyceride and cholesterol and improvement in HDL level was observed [13]. Clinical trials for other degenerative disorders yet to perform, but the proof of better lipid profile management by the mix and presence of antioxidants plus phytochemical in it confirms its effectiveness in management of NCD like diabetes, obesity, cardiovascular issues etc.

CONCLUSION

Many experimental studies are available on health benefits of different spice and herbs but value addition of these herbs to local and common food items is limited. Different degenerative disorders may be well treated with diet and lifestyle modification. Inclusion of different spice and herbs to daily diet might have sustainable positive effect on health. Further study on fortification of food items with assorted herbs for different health conditions is essential in future along with proper efficacy test. The present mix have public health nutrition importance for NCD, as it is economic, palatable, easy to prepare locally and supplemented with important antioxidants and phytochemical.

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