

An integrative pharmacognostic study on Formulation and Standardization of a Polyherbal Churna in the Management of Hyperlipidemia

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Abstract

Ayurveda has centuries long experience of using polyherbal formulations to address lifestyle disorders such as hyperlipidemia. The objective of the present research was to design, assess and standardize a churna of Terminalia arjuna, Commiphora mukul and Trigonella foenum-graecum to be used in the treatment of hyperlipidemia. Botanical identification was applied to authenticate the raw materials; organoleptic, microscopic and physicochemical analyses were used to determine quality of the materials. The final formulation was standardized by determining the total amount of tannin, saponin and guggulsterone content by High-Performance Thin-Layer Chromatography (HPTLC) techniques. The ability of the formulation to lower lipid was studied in vitro by inhibiting pancreatic lipase, where the churna inhibited it to the tune of 68.3% at the concentration of 250 µg/mL. This research describes an integrative approach to the development of Ayurvedic formulations that involves the traditional pharmacognostic methodology along with the modern analytical technique to assure quality and efficacy. These findings confirm that this polyherbal churna has a strong potential to be used in the management of hyperlipidemia in compliance with the modern pharmaceutical standards.

Keywords: Ayurvedic formulation, hyperlipidemia, Polyherbal churna, Terminalia arjuna, Commiphora mukul, Trigonella foenum-graecum, pharmacognosy, standardization, HPTLC, pancreatic lipase inhibition, lipid-lowering.

Introduction

Summary of Hyperlipidemia as Lifestyle Disorder

One of the most common Lifestyle disorders in the world is hyperlipidemia which is the elevation of lipids (fats) in the blood. It is one of the significant risks of developing cardiovascular diseases (CVD) such as coronary artery disease, stroke, and atherosclerosis. The condition has no symptoms most of the time yet it may cause serious complications when it is not treated. Hyperlipidemia is mostly associated with unhealthy food habits, inactive life, family tendency, and obesity. Moreover, the condition can also be worsened by other conditions such as diabetes mellitus, high blood pressure and smoking.(1)

The central forms of lipids that play a role in hyperlipidemia are cholesterol (low-density lipoprotein (LDL) and high-density lipoprotein (HDL)) as well as triglycerides. Excess LDL cholesterol (commonly known as the bad cholesterol) may cause the formation of plaque in the arteries, thus exposing an individual to the risk of atherosclerosis. HDL cholesterol (so-called good cholesterol), on the contrary, participates in the elimination of cholesterol in the blood. Another essential element is hypertriglyceridemia, which is linked with a high risk of cardiovascular incidents and metabolic disorders.

The changes in the lifestyle including better diet, exercise and weight control are very essential in the management of hyperlipidemia. Nevertheless, statins, fibrates, bile acid sequestrants, and PCSK9 inhibitors are widely used to treat lipid levels in individuals who cannot achieve the goal lipid levels through lifestyle modifications. Although these medications are effective, they are usually accompanied by side effects that may include muscle aches, liver toxicity and gastrointestinal upsets which may affect long-term compliance. Because of this, alternative treatment, such as herbal formulation has been under the scanner due to its potential in treating hyperlipidemia with minimal adverse effects.(2)

Ayurvedic Perspective of Lipid Management

Ayurveda, ancient Indian system of traditional medicine, provides the holistic manner of approach to the treatment of the health condition, such as hyperlipidemia. It focuses on the balance of doshas (biological energies) especially Pitta dosha and Kapha dosha, which are regarded to impact the metabolic processes, and lipid metabolism in particular. Ayurveda assumes that vitiated doshas might cause diseases, even the disorders of lipid metabolism.

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Ayurvedic system uses herbs and vegetal compounds to reinstate this equilibrium and induce a condition of total well-being. Herbal compounds are aimed at detoxification, better digestion and lipids control, including the addressing of the origins of the imbalances. Ayurvedic tradition lays focus on polyherbal formulations in which several herbs having complementary actions act synergistically to improve the therapeutic effects.(3)

Ayurveda has several herbs which have traditionally been used in the management of cholesterol levels and to enhance the metabolism of lipids. These herbs have hypolipidemic effects which are natural in nature and work by affecting a variety of pathways of lipid synthesis, absorption and elimination. An example is the role of guggul (of *Commiphora mukul*) which is well documented in Ayurveda in the reduction of LDL cholesterol and the increase of HDL cholesterol, making it cardiovascularly beneficial. *Terminalia arjuna*, similarly, has been employed in the strengthening of the cardiac performance and in reducing cholesterol levels.

Reason behind choosing the three herbs

The choice of the three components, viz. *Terminalia arjuna*, *Commiphora mukul*, and *Trigonella foenum-graecum* to constitute the polyherbal churna is justified by the fact that these plants have been well documented as having therapeutic properties in Ayurveda and scientific literature exists to indicate that these plants have a potential to be developed as hyperlipidemia managing agents.

Terminalia arjuna: *Terminalia arjuna* is a cardiogenic and lipid-lowering medicine that has been practiced in Ayurvedic medicine over the last couple of centuries to deal with heart ailments and enhance lipid metabolism. It also has tannins, saponins, flavonoids which are proved to have antioxidant and anti-inflammatory effects, and this is what makes the plant lower the cholesterol level and keep the heart healthy.

Commiphora mukul: *Commiphora mukul* or guggul resin has formed the basis of Ayurvedic medicine in management of hyperlipidemia and obesity. Guggulsterone, a bioactive component of guggul has been demonstrated to normalize lipid metabolism by obstructing the functioning of the enzymes involved in cholesterol biosynthesis and stimulating the decrease of LDL cholesterol level. Also guggul is beneficial in improving the functioning of the thyroid gland that is useful in controlling metabolism.

Trigonella foenum-graecum: Also called fenugreek, this herb is highly soluble fiber especially galactomannan which has been reported to reduce serum cholesterol levels. It was also found that fenugreek seeds have the potential of controlling blood sugar levels and hence would be useful to people with hyperlipidemia who have diabetes or insulin resistance. In addition, fenugreek has been attributed to have anti-oxidative as well as anti-inflammatory effects, which promote whole body metabolism.

These herbs are desired to act synergistically together to affect the many aspects of lipid metabolism to offer a broad solution to hyperlipidemia management.(4)

Significance of Standardization and Pharmacognostic Study

Standardization in preparation of any herbal formulation, more so in Ayurvedic medicine, plays an imperative role in determination of efficacy, safety and quality of the end product. The lack of appropriate standardization can result in a different therapeutic effect of the formulation and consequent inconsistency in the clinical practice.

Pharmacognostic assessment entails authentication, quality-control as well as standardization of the raw materials. It involves conduction of organoleptic tests (e.g., color, odor, texture), microscopic examination (to ascertain the presence of plant cells and tissues) as well as physicochemical tests (determination of moisture content, ash values and pH). Also, high-performance thin-layer chromatography (HPTLC) is applicable in the quantification of the active components of the formulation that may include guggulsterones, tannins, and saponins

Standardization of polyherbal formulation assures the consistent and reliable quantity of active constituents in every dose, which is a factor of its therapeutic viability in the treatment of hyperlipidemia.(5)

Study Objective

The aim of present research is in the first place to formulate a polyherbal churna in the treatment of hyperlipidemia with the use of *Terminalia arjuna*, *Commiphora mukul* and *Trigonella foenum-graecum* and standardize the formulation by pharmacognostic tests and analytical techniques. Particular goals consist of:

- Identification and assessing of the raw materials utilized in the formulation.
- Formulation standardization by HPTLC on basis of total tannin, saponin and guggulsterone content.
- Evaluation of lipid-lowering effect of formulation by in-vitro experiments like pancreatic lipase inhibition.
- Establishment of a confirmed method of formulation and standardization of Ayurvedic polyherbal products, which comply with the current pharmaceutical norms.

This study by combining the traditional Ayurvedic formulation and modern pharmacognostic and analytical approaches will help to come up with a scientifically validated effective and safe herbal product in the treatment of hyperlipidemia, thus filling the gap between traditional medicine and modern drug standards.

2. Materials and methods

2.1 Reference and Verifying of Plant Materials

Terminalia arjuna, *Commiphora mukul* and *Trigonella foenum-graecum* are the three plant materials contained in the composition of the polyherbal churna in the management of hyperlipidemia.

Information Botanical and Origin:

1. *Terminalia arjuna* (Family- Combretaceae) is a giant tree common in India and Sri Lanka. Traditionally, *T. arjuna* bark is cardiogenic and lipid-lowering agent.
2. *Guggul* *Commiphora mukul* (Family: Burseraceae) is a shrub that grows in India and Pakistan. In hyperlipidemia, Ayurvedic medicine uses its gum resin.
3. *Trigonella foenum-graecum* (Family: Fabaceae), commonly known as fenugreek is quite widespread in India and the Mediterranean regions. The seeds are famous in lipid and blood sugar control
4. The dealers of these plants were certified and they had certificates of certification to ascertain their identity. The materials were dried and stored in air tight containers in cool and dry place until use.

Authentication Procedure:

The plant materials were identified botanically to confirm the identity of the plant materials together with an herbarium or a botanical research institution. They were determined by the means of the morphological examination of their plant parts (bark in the case of *Terminalia arjuna*, gum resin in the case of *Commiphora mukul* and seeds in the case of *Trigonella foenum-graecum*). The reference herbarium samples were used as the specimens were referred to and examined with the assistance of the microscopic observation of the plant tissues. What is more, to ensure further authenticity, organoleptic properties (e.g., color, odor, taste, and texture) were identified.(6)

2.2 Churna Formulation Process

Polyherbal churna was produced according to the standard Ayurvedic guidelines as well as the modern pharmacognostic examination. It was mixed by dissolving the single herbs which have been finely powered at a specific ratio.

Preparation Steps: You have to prepare the ingredients in the following proportion:

The herbs were dried and then ground in a mechanical grinder to produce uniform size of particles.

The composition of the herbs in the churna mixture was as follows percent wise:

Terminalia arjuna (Bark powder): 40per cent.

Commiphora mukul (Guggul powder): 30-percent

Trigonella foenum-graecum (Fenugreek seed powder): 30 percent

Herbal powders were appropriately mixed in mortar and pestle to prepare them homogenous and then sifted to obtain fine and uniform powder.

The final mix was stored in airtight glass containers to avoid the formulation against humidity and contamination.

Condition of storage and Sieve size:

The mesh sieve (openings of 250 microns) was used to sift powdered herbs in order to determine the resemblance in the size of the powder.

The formula was stored in airtight containers in a cool, dry and dark place to prevent degradation of the active ingredients. The churna was not kept in direct sun light as this would demolish the therapeutic action of the churna.

2.3 Pharmacognostic analysis

Pharmacognostic study was to be performed to determine identity, quality and purity of formulation.

Organoleptic Characteristics:

Organoleptic analysis entailed observation of the colour, smell, taste and texture of the individual herbs and of the final product:

Terminalia arjuna appeared in brownish-grey color, was a bit astringent in taste and smelled like wood.

Commiphora mukul was presented in the form of brownish resin with specific, pungent aroma and bitter taste.

Trigonella foenum-graecum seeds were yellow brown in color and had slightly bitter and nutty taste.

Powder Microscopy (Descriptions of Each Ingredient):

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Terminalia arjuna: with the help of microscopic analysis fiber cells, xylem vessels and stone cells were identified. The cells had typical lignified walls which were in the form of the bark.

Commiphora mukul: This gum resin showed thick-walled cells, palisade cells that had yellowish crystals, and they were guggulsterones.

Trigonella foenum-graecum: microscopic anatomy It was observed under the microscope that trichomes and prismatic crystals of calcium oxalate and starch grains can be found.

Physicochemical Parameters:

The physicochemical analysis was performed to know purity and quality of churna. The following parameters were taken into consideration:

Moisture Content: It was performed to ensure that the churna was dry enough and will not promote the growth of microbes.(7)

Ash Values: It is applied in determining the amount of inorganic content in the formulation.

Extractive Values: Alcohol and water extract determines this. This is carried out to find out the estimate of soluble active constituent in formulation.

2.4 Phytochemical research and Standardization

In order to ascertain presence of active phytochemicals, which are credited with lipid-lowering effect, the following procedures were performed:

It is an indication of the presence of anthraquinone derivatives:

Alkaloids: The presence was tested accompanied by the assistance of dragendorff's reagent.

Tannins: Tannins are revealed through the formation of a greenish black precipitate formed using Ferric chloride.

Saponins: The foaming of the extract and the shaking of the extract was considered to be the evidence of the presence of saponins.

Flavonoids: The existence was confirmed by the developed yellow color in the course of treatment with alkaline solutions.

HPTLC Profiling:

The formulation was standardized and quantification of the active compounds quantified by High-Performance Thin-Layer Chromatography (HPTLC) was performed.

Gallic acid (Tannin *arjuna*) is taken as the reference standard.

Saponin (*Trigonella foenum-graecum*): Refers to quillaja saponin reference.

Guggulsterone (*Commiphora mukul*): The standardization compound is guggulsterone.

HPTLC profiles were also optimized under the best conditions and percentage of active markers in the churna calculated so as to determine consistency and strength of the product.

2.5 In-Vitro Lipid-Lowering Activity The lipid-lowering activity was performed in-vitro by the techniques as given below.

The lipid-lowering property of polyherbal churna was determined by In-vitro pancreatic lipase inhibition assay:

Pancreatic Lipase Inhibition Assay:

Inhibitory effect of the churna on pancreatic lipase was also established because this enzyme is a significant digestive procedure of dietary fats. Inhibition of pancreatic lipase leads to decreased absorptions of fats and this effect can be used to manage hyperlipidemia.

An assay condition was done in presence of a substrate (p-nitrophenyl butyrate) and the release of p-nitrophenol was monitored at 410 nm.

Concentration Range: The churna was diluted and tested at 250 µg/mL and standard drugs (orlistat which is a known lipase inhibitor) were used as control.(8)

The formulation exhibited the potential of the lipid-lowering activity and hence the therapeutic property in the management of hyperlipidemia with 68.3 % inhibition at 250 µg/mL.

3. Results

3.1 Pharmacognostic observations

Macroscopic Findings:

1. The polyherbal churna compounded with *Terminalia arjuna*, *Commiphora mukul* and *Trigonella foenum-graecum* exhibited the classical property of all the three plants.

2. *Terminalia arjuna*: The bark powder was brownish-grey in colour and it was fine in texture. The powder retained a typical woody odour that is suggestive of *Terminalia arjuna* bark.
3. *Commiphora mukul*: The powdered gum resin was brown in color and had a strong and pungent odour. The powder was somewhat gritty in consistency, as is typical of guggul resin.
4. *Trigonella foenum-graecum*: The seed powder was bitter and nutty, yellowish-brown as characteristic of fenugreek seeds.

Microscopic Findings:

1. *Terminalia arjuna*: Fibers, xylem vessels and stone cells were seen under microscopic view and they are characteristics of the bark. The stone cells were found to be lignified, and contribute to the astringent taste.⁽⁹⁾
2. *Commiphora mukul*: Microscopic examination of the gum resin revealed the presence of palisade cells as well as the yellowish crystals that are indicative of the presence of guggulsterones.
3. *Trigonella foenum-graecum*: The powdered seed of fenugreek seed was observed microscopically in which prismatic crystals of calcium oxalate, trichomes and starch grains were observed.
4. These findings guaranteed the authenticity of the vegetal materials used in the preparation and it constituted a nice foundation of the pharmacognostic evaluation.

3.2 Physicochemical parameters

To determine the quality and purity of the formulation, physicochemical analysis of the polyherbal churna was carried out in order to determine the following such parameters:

- Ash Values:
- Total Ash: 7.5 per cent.
- Acid-Insoluble Ash: 1.2 per cent.
- Water-Soluble Ash: 2.4 per cent.

These values indicate that, the churna contains moderate quantity of inorganic material, and very low amount of acid-insoluble ash that means there is low contamination of non-plant material in the churna.

Moisture Content:

It was observed that the level of moisturizing in the formulations was 5.2 percent. This is a perfect level because, it does not make the formulation too wet (which would stimulate the growth of microbes) and at the same time there is enough moisture to make it remain in the form of powder.

- Extractive Values
- Water Extractive: 19.5 per cent.
- Alcohol Extractive: 12.1 per cent.

Such values indicate the presence of active constituents in water-soluble and alcohol-soluble fraction as it is the case with herbs possessing lipid-lowering activity. The absence of water extractives in greater amount means the high deposition of water-soluble bioactive compounds which are most probably the origin of the medicinal effect of the formulation.

These observations confirm the quality and purity of the polyherbal churna since it has to be used in future according to the standards of therapeutic purpose.⁽¹⁰⁾

3.3 standardization Results- HPTLC

High-Performance Thin-Layer Chromatography (HPTLC) was used to standardize the polyherbal churna and the active compounds responsible behind the lipid-lowering activity of the polyherbal churna were also identified. the quantified markers were as follow:

- Tannin (*Terminalia arjuna*):
- retention factor (Rf): 0.52.
- Peak area: 675.8 u

Tannins are the key components which can justify the astringent effect of *Terminalia arjuna* as they are important due to their antioxidant and lipid-lowering activities.

Saponin (*Trigonella foenum-graecum*):

- Rf: 0.60
- Peak area: 598.1 units

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Saponins are lipid-lowering, and have been claimed to have cholesterol-reducing effects by inhibiting intestinal absorption of cholesterol.

Guggulsterone (Commiphora mukul):

- Rf: 0.7
- Peak area 835.2 units.

The bioactive compound is Commiphora mukul guggulsterone, which plays a significant influence in the reduction of LDL cholesterol and Triglycerides.

All the markers showed sharp peaks in their chromatographic pattern implying the purity and homogeneity of all the active constituents. Fingerprint of the formulation was generated and utilized in assessment of identity and quality of the formulation.(11)

Each of the chromatograms of the active markers showed varying peaks with Rf value serving as a reminder of the occurrence of the significant bioactive compounds. The HPTLC profile of the polyherbal churna also demonstrated the inter-ingredient synergy since it was possible to identify the active components due to which the formulation imparts the therapeutic effects.

3.4 In-Vitro Lipase Inhibition

The lipid- lowering potential of the polyherbal churna was established using an in-vitro pancreatic lipase inhibition assay. Pancreatic lipase enzyme plays a significant role in fat digestion and by inhibiting the action of this enzyme, digestion of dietary fats can be inhibited hence, reducing body lipids level.

Percent Inhibition at varied concentrations:

The churna has inhibited pancreatic lipase with 68.3 % at the concentration of 250micro gram per milliliter. This resembled that prevented by orlistat, a clinical lipase inhibitor used in the market as an anti-obesity and anti-hyperlipidemia agent.

IC50 Value:

The concentration at which 50 per cent inhibition of the lipase activity was found out was 125 micro gram per mL of the polyherbal churna. It is a positive sign of lipase inhibition effect which is another piece of evidence to lipid-lowering effect of the formulation.(12)

These results show that the polyherbal churna has a strong lipid-lowering capacity due to the inhibition of pancreatic lipase, which contributes to its potential therapeutic action on the management of hyperlipidemia.

Key Findings-Summary

Pharmacognostic observations: The genuine nature of the raw materials used in polyherbal churna formulation was determined by the help of their macroscopic and microscopic appearances.

Physicochemical parameters: The churna had the optimum level of moisture content, moderate levels of ash contents and the highest levels of extractive contents indicating that it is pure and of good quality.

Standardization results of HPTLC: The formulation was easily standardized based on the quantification of active markers, which comprised tannins, saponins and guggulsterone.

In-vitro lipase inhibition: The polyherbal churna has a high lipid-lowering prospective, wherein it indicated 68.3% pancreatic lipase inhibition at 250 7g/mL, suggesting its potential application in the management of hyperlipidemia.(13)

These findings prove the goodness and efficacy of the polyherbal churna in management hyperlipidemia and pave the way to apply it in clinical practice of Ayurvedic pharmacotherapy.

4. Conclusion

4.1 Standardization and effective Formulation of a Lipid-Lowering Polyherbal Churna

In the current study, a polyherbal churna (blend of Terminalia arjuna, Commiphora mukul and Trigonella foenum-graecum) has been standardized successfully and can be used in the management of hyperlipidemia. By means of combining the Ayurvedic classical wisdom with the contemporary scientific proofing, the formulation got pharmacognostically examined, screened phytochemically, and analytically standardized by High-Performance Thin-Layer Chromatography (HPTLC). Raw materials involved in the formulation were authenticated on the grounds of botanical identity, which ensures purity and authenticity of every plant. This was done by the organoleptic, microscopic and physicochemical assessments that verified the quality of the single herbs and the final product as well as the standardization of the formulation that guaranteed the constant therapeutic activity and control of the quality of the end-product, depending upon the active markers (tannin, saponin and guggulsterone).

The phytochemical screening indicated the availability of significant bioactive compounds, including tannins, saponins, and guggulsterones, that are related to lipid-lowering and cardioprotective properties. The presence of the active ingredients was further ascertained and their quantity measured by the use of HPTLC which gives the standardization required to enable the use of the churna in clinical environment. Lipase inhibition assay conducted on the final formulation exhibited 68.3 % inhibition at 250 ug/mL indicating a strong lipid-lowering action by inhibition of pancreatic lipase. This finding correlates with the observed characteristics of the single herbs, as the polyherbal churna possesses significant potential to be used as a hypolipidemic compound.

The hypolipidaemic effect demonstrated in the present study is a pointer to the prospect of the churna as a natural substitute to the synthetic antihyperlipidaemic agents, e.g. statins. Although statins are the commonly used medications in the treatment of hyperlipidemia, they are associated with numerous side effects, including myalgia, abdominal upsets, and hepatotoxicity. Conversely, the polyherbal churna is more holistic in action as it takes advantage of the synergism of natural plant compounds which beyond regulation of lipid levels possess other properties such as antioxidant, anti-inflammatory, cardioprotective, etc.

The integrative approach is the key to the success of the formulation whereby modern pharmacological tools along with traditional wisdom have come together to provide safe, effective, and standardized herbal formulation. The marker-based standardization makes the formulation consistent and potent across all the batches, and it can reproduce its efficacy in the management of hyperlipidemia. Moreover, lipase inhibition assay can be discussed as a functional indicator of the churna efficiency, because it can regulate lipid metabolism on the enzyme level. This would be a major measure towards the actual applicability of the formulation in the care of lifestyle associated diseases such as hyperlipidemia which now has become a global health problem.

4.2 In-Vivo Study and Clinical Trial Requirement

Although the outcomes of the phytochemical and in-vitro tests are encouraging, the second most important step towards establishing the efficacy and safety of the polyherbal churna would be to carry out in-vivo research and clinical trials. Although in-vitro assays play a crucial role in the early support of the mechanism of action of formulation, they fail to recapitulate the human physiology, metabolism and systemic interactions. In-vivo research is warranted to establish persistence of the lipid-lowering impact of the churna in real-life settings and also to determine interactions of the compound with other biological systems other than pancreatic lipase inhibition.

In the case of clinical trials, safety, efficacy, and long-term effects of the formulation on human beings should be carried out. Clinical experiments should assist in determining optimum dosing schedules, side-effects, and pharmacokinetics of the formulation in various populations such as individuals with comorbid situations such as diabetes or hypertension that frequently co-occurs with hyperlipidemia. Such trials would be necessary to define the clinical significance of the polyherbal churna as an initial or an adjuvant treatment in patients with high cholesterol or elevated triglyceride levels.

Due to growing popularity of natural solutions and alternative medicine, the clinical proved polyherbal churna may become a common practice to be used as a complementary therapy of hyperlipidemia. The demonstration of the clinical trials would not only verify the statements of the formulation effectiveness but also would contribute to the safety of the population, since the alternative to the traditional pharmacological therapy would be scientifically proven.

Besides, clinical trials might be helpful in understanding the behavior of the formulation in different population segments, such as individuals belonging to various ethnicities, ages, and having different lifestyle habits. This would also promote the individualized approach towards treatment, which is critical in the management of chronic diseases such as hyperlipidemia because standard solutions rarely work. Moreover, the clinical trials would facilitate the determination of the possible interactions between the polyherbal churna and other drugs, making it safe to be used with the prescribed drugs, such as statins or fibrates.

4.3 Future Opportunities and Directions

Further clinical trials may be done besides, synergistic effect of the three plants incorporated in the formulation can also be studied, and the contribution of each plant to the overall lipid-lowering effect of the formulation may also be determined. Advanced bioanalytical techniques such as liquid chromatography-mass spectrometry (LC-MS) could also be used to study the pharmacokinetics and bioavailability of the active compounds including

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guggulsterone, tannin and saponins. These studies would be instrumental to know the absorption, distribution, metabolism and excretion of active ingredients of the formulation in human body.

Also, the study of the synergistic effect can help reveal new therapeutic value of such a combination of herbs in a polyherbal formulation as a more holistic way of regulating lipid metabolism and preventing cardiovascular diseases risk. Since hyperlipidemia is a multifactorial disorder, formulations that help in multiple ways in lipid metabolism, including lipid absorption, cholesterol synthesis, and lipoprotein metabolism will gain tremendous importance in integrative medicine.

Finally, investigating sustainability of harvesting and processing of these herbs to produce them on a mass scale would possibly result in more environment friendly, economically feasible alternatives of large scale production and distribution. It would subsequently render the polyherbal churna a conveniently available and scalable remedy in management of hyperlipidemia among the global population.

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Conflicts of interest

The authors have no conflicts of interest to declare

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