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RESEARCH ARTICLE

DEVELOPMENT AND SENSORY EVALUATION OF *TRIBULUS TERRESTRIS* (L) FRUIT POWDER INCORPORATED INTO THE RICE RECIPES

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ABSTRACT

Presently the whole world is hoping to make "FOOD IS THY MEDICINE" come true. People look out for healthy but functional foods for the management or prevention of disorders. Healthy foods may be developed with medicinal herbs, in order to make its consumption palatable and frequently consumable. In the present study, it has been embarked to venture in developing common South Indian rice based recipes incorporated with *Tribulus terrestris* (an aphrodisiac herb) fruit powder and to evaluate them organoleptically by using 9 point hedonic scale. Though different colour rice are available, in this study white rice (*Oryza Sativa*) is used. *Tribulus terrestris* fruit powder has been documented to treat various disorders namely urinary tract infections, sexual dysfunction, diabetes, lead toxicity, etc. In this trial, *Tribulus terrestris* fruit powder has been incorporated at the rate of 10g, 20g and 30g. However, in comparison with the standard recipes, 10g *Tribulus terrestris* fruit powder added recipes were found to be competent and acceptable. Particularly, Adai recipe had the highest organoleptic score than the standard recipe. Similarly, 20g of *Tribulus terrestris* fruit powder added Kolukattai scored higher than 10g recipe but relatively lesser than the standard recipe. However, on the whole in all the recipes particularly *Idly*, *Dosa*, *Puttu*, *Upma* and *Idiyappam* addition of 10g of *Tribulus terrestris* fruit powder made it comparable with the standard recipes and were highly acceptable. Thus the present study appreciably recommends aggressive inclusion and utilization of *Tribulus terrestris* fruit powder in the Indian recipes in order to alleviate the toxicity and complications that might occur due to the lead pollution as India is widely vulnerable to this heavy metal pollution.

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INTRODUCTION

Variety of rice varies with the region and nutritionally differs according to its species and nutrient composition. Some of the varieties also vary in their colour according to their pigments and antioxidants present. (Itani and Ogawa, 2004) in their study mentioned that red rice has gained popularity in Japan as a functional food due to its high polyphenols and anthocyanin content. Similarly black rice has also been shown to possess nutritional advantages over common rice such as higher protein content, vitamins and minerals (Suzuki *et al.*, 2004) or as an organic food colouring agent (Chaudhary, 2003). Yet other grains and agricultural products are also consumed by Asian population. Apart from pesticides used by most of these agricultural countries, people also get exposed to industrial pollutants which mostly result in dreadful chronic toxicity. Similarly, the environmental exposure of certain chemicals could also bring in chronic toxicity. Lead is such one that is widely and commonly available toxic constituent across the World.

Lead is the major toxic heavy metal globally considered as number one environmental poison and health hazard affecting millions of people in all age groups (Thuppil Venkatesh, 2009). It is also one of the most abundant natural substances and is the fifth metal that is widely used throughout the world (Karrari *et al.*, 2012). Its easy availability and cost effectiveness made lead as an extremely popular component in the industrial revolution. However, its hazardous health effects were not considered at the time. Over the last few decades, with the adverse effects of lead coming to the forefront, nations across the world have started to recognize and treat lead toxicity (Herman D'souza, 2011).

Inhalation and ingestion are the two most common routes of entry of lead into the body. Although ingestion is more common source, inhalation is the most significant as pulmonary absorption is efficient. Lead is absorbed in the blood plasma where it equilibrates with the extracellular fluid, crosses membranes such as the blood brain barrier and placenta, and accumulates in soft tissues and bones. Lead that is stored in bones can have a half life of up to 28 years and can be mobilized intermittently at times of stress, lactation or

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hormonal imbalances (Verity, 1990). Gastrointestinal ingestion is the most important source of lead intake in the body as lead does not have a feedback mechanism to inhibit its uptake (Sipos., 2003). Furthermore, dietary components, such as, sodium citrate, ascorbic acid, amino acids, vitamin D, proteins, fat and lactose can bind to lead and thus enhance the absorption of lead (DeMichele, 1984)

Lead is known to induce a broad range of physiological, biochemical, and behavioural dysfunctions in laboratory animals and humans (Flora *et al.*, 2006), including central and peripheral nervous systems (Bressler *et al.*, 1999), haemopoietic system (Lanphear *et al.*, 2000), cardiovascular system (Khalil- Manesh *et al.*, 1993), hepatic (Patra *et al.*, 2001) and male (Lancranjan *et al.*, 1975) and female reproductive systems (Ronis *et al.*, 1998). Such derangements are expected to occur at cellular level by increasing oxidative stress. Thus, lead is found to increase oxidative stress by the production of free radicals and decreasing antioxidant capacity resulting in cell apoptosis (Thuppil, 2014). In the past decades, after recognising the ill effect of lead exposure, scientific community has taken the challenge to resolve it and has been seeking strategies to overcome the toxicity in multiple ways including pharmacognosy. Various plants and their parts have been identified as detoxifiers and cell replishners worldwide.

Plant species play a very important role in the protection of kidney and liver as well as against cardiac disorders due to the presence of phytochemicals (Saurabh *et al.*, 2014). The medicinal properties of several herbal plants have been identified and documented in a number of ancient literature and the use of herbal plants have been found to be effective in the treatment of various diseases. The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body. The most important of these bioactive constituents of plants are alkaloids, tannins, flavonoids and phenolic compounds (Dorman *et al.*, 2000)

Such antioxidants are also present in many of the plants and their products. *Tribulus terrestris* a flowering plant of the Zygophyllaceae family, is The genus *Tribulus*, belonging to family Zygophyllaceae, comprises about 20 species in the world, of which three species, viz. *Tribulus cistoides*, *Tribulus terrestris*, and *Tribulus alatus*, are of common occurrence in India (Trease *et al.*, 2002). Among them, *T. terrestris* (TT) is a well-patronized medicinal herb by Ayurvedic seers as well as by modern herbalists and native to warm temperature and tropical region. It can thrive even in desert climates and poor soil (Duk *et al.*, 2002). The plant is used individually as a single therapeutic agent or as a prime or subordinate component of many compound formulations and food supplements. It is an annual shrub found in Mediterranean, subtropical, and desert climate regions around the world, viz. India, China, southern USA, Mexico, Spain, and Bulgaria (Saurabh *et al.*, 2014). However, this plant or its parts has been seldom tried as detoxifier or cell replenisher. Hence, an effort was put upon to explore the protective effect of TT fruit extract powder on the lead toxicity by Sasikala *et al.* (2013), whose fairly successful results lead to a concept of incorporating this plant product into our common Indian recipes as otherwise this plant has only been used as Ayurvedic medicine (Sasikala *et al.*, 2013).

Thus, in the present study rice has been used as the main ingredient to formulate recipes as Rice (*Oryza sativa*) is the major and staple cereal crop of over half of the world population. In China and India whose people constitute almost half the world's population, rice serves as the staple food for their daily life (Sasaki and Burr, 2000) and unsurprisingly, 95% of the world rice production is in Asian countries (Bhattacharjee *et al.*, 2002). Pigmented rice varieties are usually named according to their bran colour formed by deposition of anthocyanins in the pericarp, seed coat and aluerone (Chaundry, 2003). Pigmented rice is a potential source of antioxidants in various types of functional food production (Yawadio *et al.*, 2007). Potential antioxidative phytochemicals such as acetylated procyanidin, anthocyanins, and other phenolic acids, which can be found in these pigmented rice, can help prevent oxidative stress, inhibits the initiation and formation of cancer, reduces plasma cholesterol levels and may prevent cardiovascular disease (Romero, 2009). Therefore, this is yet another reason why black-purple rice was also selected to make recipes besides white rice.

Hence, both pigmented and white rice were used to formulate recipes using with *Tribulus terresteris* and thereby assessing their organoleptic properties. Also, ranking for their sensory evaluation has also been carried out.

Objectives of the study

1. To formulate and standardize Indian recipes using *Tribulus terrestris*.
2. To carry out organoleptic evaluation of the same Indian recipes.

MATERIALS AND METHODS

Development and standardization of south Indian recipes incorporating *Tribulus terrestris* recipes

Two sets of south Indian recipes using white rice and Black Purple Rice (Kavanai Rice) were developed by incorporating *Tribulus Terrestris* (L) fruit powder at the proportion of 10%, 20% and 30%. The recipes were repeated in human trials, altering the quantities of ingredients in definite proportions which produced similar results of the product. Thus, the recipes of the products desired were standardized.

Sensory evaluation

The formulated recipes were subjected to sensory evaluation to test the acceptability using a nine point hedonic scale, where 9=liked extremely, 8=liked very much, 7=liked moderately, 6=liked slightly, 5=neither like or dislike, 4=disliked slightly, 3=disliked moderately, 2=disliked very much, 1=disliked extremely.

Criteria for selection of judges for sensory evaluation

The following were the criteria for the selection of judges for the sensory evaluation

- Willingness to participate in the study.
- With normal taste sensitivity-free from any oral problems that could affect taste.

- Not allergic to the ingredients used in the formulation of the recipes.
- Free from illness.

Based on the criteria for selection mentioned above, thirty panel members with normal taste sensitivity and who were not allergic to the ingredients used in the recipes were chosen as judges for the sensory evaluation. The score card for the evaluation of the recipes was provided along with instructions to each judge before evaluation. Each member indicated the extent of their likes or dislikes in terms of colour, appearance, aroma, taste, overall acceptability. The sensory score of both white rice with *Tribulus terrestris* and black rice (Kavani rice) with *Tribulus terrestris* for each parameter were subjected to statistical analysis to calculate mean scores.

Preparation of *Tribulus terrestris* (L) fruit powder

The healthy plant samples of *Tribulus terrestris* (L) plant were collected from Coimbatore District Tamil Nadu, India. The plant material was authenticated by a skilled taxonomist at Botanical Survey of India and a voucher specimen (NO: BSI/SRC/5/23/2013-2014/TECH/1024) was deposited at the Tamil Nadu Agricultural University, Coimbatore. The fresh fruits of *Tribulus terrestris* (L) was collected and were dried in the shade, powdered and stored in a sterile and in a tight container for further use, which was later incorporated into white and black rice (kavani rice) formulations.

Recipe formulation

Seven recipes namely idly, dosa, puttu, kolukattai, idiyappam, adai, uppma were formulated, standardised and supplemented with *Tribulus terrestris* fruit powder at the rate of 10, 20 and 30 grams as variations. However a standard recipe using only black rice or white rice were also formulated and standardised. In fact, this was considered as normal standard recipe which were then compared with the test recipes with their selected sensory attributes, namely colour, appearance, aroma, taste and overall acceptability.

Recipes prepared with different methods of cooking by incorporating *Tribulus terrestris* into white and black rice

Food preparations	Method of processing
Adai	Steaming
Kolukattai	Steaming
Idiyappam	Steaming
Idly	Steaming
Dosa	Roasting
Puttu	Steaming
Uppma	Boiling & Seasoning

Statistical analysis

Garrett’s Ranking

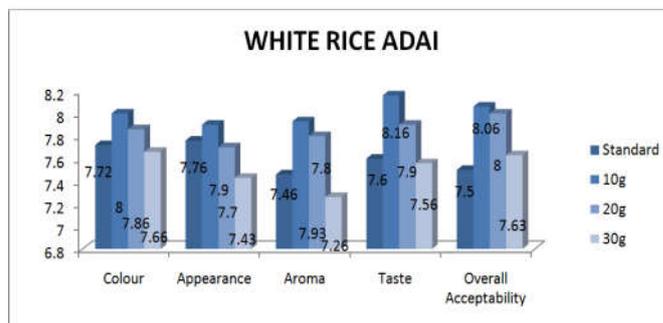
Garrett’s test has been used to analyse the factors influencing the preferences of the respondents for the overall acceptability of Indian recipes prepared with black rice and white rice with the addition of *Tribulus terrestris* fruit powder. Under the garretts’ ranking technique average score is calculated by multiplying the number of respondents ranking that factors as

9,8,7,6,5,4,3,2,1 by their respective table values given. Mean score is calculated by dividing average score by number of respondents. The respondents were asked to rank the five factors identified for the purpose of the study as 1, 2,3,4,5. Rank 1 is the highest percentage position whereas rank 5 is the least percentage position. It is said that according to Garretts’ ranking the factors which induces respondents to show preferences of various recipes in different proportions are namely colour, appearance, aroma, taste, overall acceptability. Garrett’s’ ranking technique is to find out the most significant factor which influences the respondent.

RESULTS

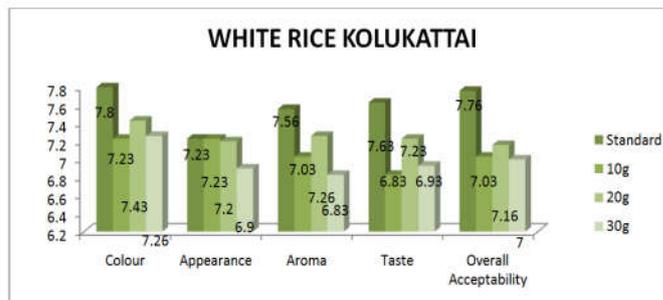
Mean 9 point hedonic scale score of white rice Adai

With reference to organoleptic attributes of *White Rice Adai* in terms of mean 9 point hedonic scores the white rice adai incorporated with 10g of *Tribulus terrestris* fruit powder consistently scored high. This superiority in the score was found with all quality characteristic including colour, appearance, aroma, taste and overall acceptability. Particularly, with regard to taste white rice adai 10g of *Tribulus terrestris* fruit powder scored the highest with the mean score of 8.16 out of 9. Whereas, as far as this recipe is concerned even the standard was having a lowest score and the recipe added with 30 g of *Tribulus terrestris* fruit powder score the least. However, the recipes with 20g of *Tribulus terrestris* fruit powder score high next to recipe with 10g of *Tribulus terrestris* fruit powder.



MEAN 9 point hedonic scale score of white rice kolukattai

With this recipe the mean 9 point hedonic scale was the highest for the sensory characteristic of colour, aroma, taste along with the score for overall acceptability.

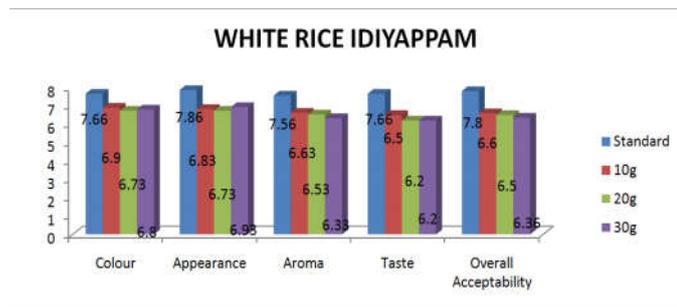


Whereas the mean score of appearance of standard *White Rice Kolukattai*, 10g of *Tribulus terrestris* fruit powder added *White*

Rice Kolukattai as well as for 20g of *Tribulus terrestris* fruit powder added *White Rice Kolukattai* were almost similar which imparts that even after the addition of *Tribulus terrestris* fruit powder at the rate of 10 and 20g, the appearance has not changed markedly.

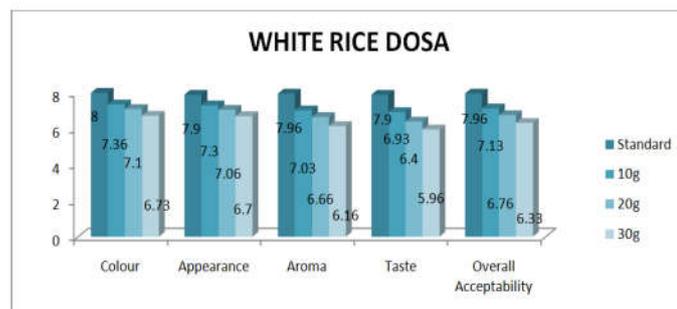
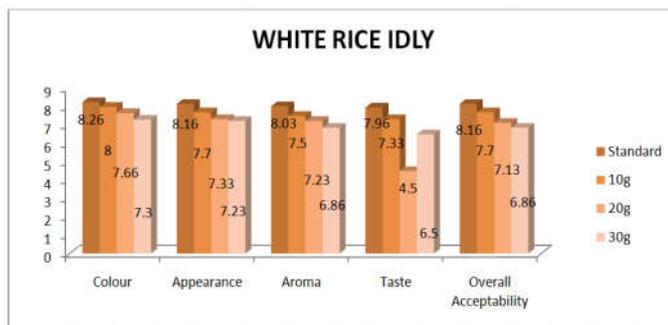
Mean 9 point hedonic scale scores of white rice Idiyappam

With regard to all the characteristics of quality the standard recipe scored high with the mean score of 7.66 to 7.86. Whereas, the recipe added with 10,20 and 30g of *Tribulus terrestris* fruit powder scored almost similar in all the organoleptic attributes mainly, colour, appearance, aroma, taste and overall acceptability. Hence *white rice idiyappam* even after adding all the three proportions (10, 20, 30 g) did not make any difference in their score and only the standard white rice idiyappam stood high in the 9 point hedonic score.



Mean 9 point hedonic scale scores of white rice idly

With reference to *white rice idly* added with 10g of *Tribulus terrestris* fruit powder stood next to standard white rice idly's score in all organoleptic parameters. However, taste wise white rice idly 20g of *Tribulus terrestris* fruit powder scored the least of 4.5. However in all the other parameters proportionately as the addition of *Tribulus terrestris* fruit powder is more correspondingly the scores were low.

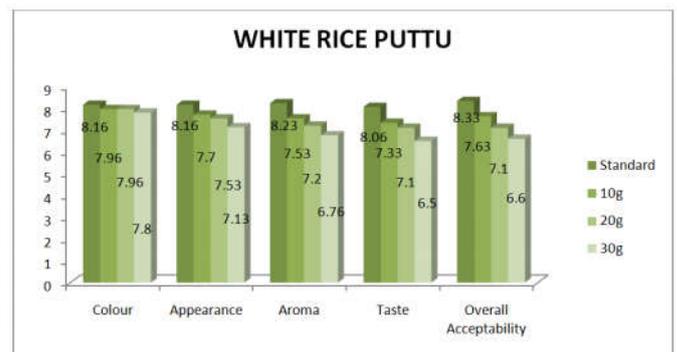


Mean 9 point hedonic scale scores of white rice Dosa

With this recipe also, the standard scored the highest ranging from 7.9 to 8 whereas the other proportion had the score lower in proportion in *Tribulus terrestris* fruit powder added.

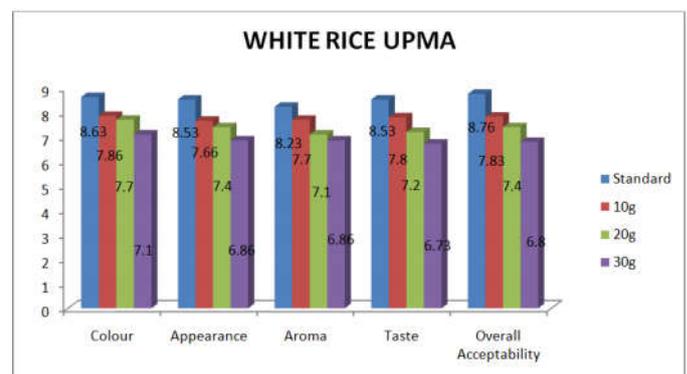
Mean 9 point hedonic scale scores of white rice Puttu

With reference to the criteria colour and appearance, the *white rice puttu* added with 10g of *Tribulus terrestris* fruit powder scored almost similar to that of standard recipe. Whereas with regard to the other organoleptic attributes namely aroma, taste and overall acceptability, the test recipes scored lower directly proportional to the increase in the concentration of *Tribulus terrestris* fruit powder added.



Mean 9 point hedonic scale scores of white rice Upma

As it has been observed in dosa, in this recipe too, the 9 point hedonic scale scores fell lower sequentially as the concentration of the test substance (*Tribulus terrestris* fruit powder). However, the recipe added with 10g of *Tribulus terrestris* fruit powder scored next to the standard recipe. Thus, with regard to all the recipes, the product added with 10g of *Tribulus terrestris* fruit powder consistently scored next to the standard recipes and stood top most among the test recipes.



DISCUSSION

Utilization of herbs plant extract or plant derived bioactive compounds for disease manual has become the therapeutic modality. However, more than the therapeutic agents as chemicals or derived extracts as such have not been appreciably acceptable, since people considered as medicines. Fruits and seeds of *Tribulus terrestris* (Zygophyllaceae) are of

significant importance in oriental medicine because they have been used as an aphrodisiac (Adaikan *et al*, 2000), diuretic (Kumari *et al*, 1967) and anthelmintic (Anand *et al*, 1994) also to treat coughs, kidney failure and sexual dysfunction. *Tribulus terrestris* (L) has been documented to have antimicrobial, antihypertensive, diuretic, ant acetylcholine, haemolytic activity, spermatogenesis and libido enhanced, antitumor activity and effects on cardiovascular system (Bowen *et al*, 1990). Such medicinal benefits may be attributed to specific bioactive compounds that are present in either plants or roots of this species. Furostanol and spirostanol saponins, flavanoid glycosides, alkaloids, steroidal saponins named terestrosins A,B,C,D and E,F-gitonis,gitnin and amides have been reported to occur in *Tribulus terrestris* (L). This plant characterized by the above mentioned phytochemicals have been used as a folk medicine as a tonic, aphrodisiac, palliative, astringent, stomachic, antihypertensive, diuretic (Singh *et al.*, 1991), lithon-triptic cordial drug and urinary anti- infective. The ash of the whole plant is good for external application in rheumatic – arthritis.

Considering the above facts an idea was conceptualized to incorporate *Tribulus terrestris* fruit powder in the food stuffs and make it as a therapeutic food rather than giving it as derived therapeutic agent. As rice has been commonly used as a staple recipe in south Indian cuisine, thus south Indian recipe using rice were selected for the present study.

On addition of 10, 20,30g of *Tribulus terrestris* fruit powder in Indian recipe significantly varied in their organoleptic assessment scores. In all the analysis of sensory attributes namely colour, appearance, aroma, taste, overall acceptability in comparison with the standard south Indian recipes are adai, kolukattai, idiyappam, idly, dosa, puttu, upma added with 10g of *Tribulus terrestris* fruit powder ranked first among all the three proportion. Hence, from this evaluation of organoleptic parameters it is imperative that even an addition of 10g of *Tribulus terrestris* fruit powder into the south Indian recipe is highly competent to the standard recipes and was appreciably acceptable. The study of Pallavi and Beena (2010) recommended that 20 different Indian recipe added with different levels (0, 5, 10, 15 and 20 %) of green leafy vegetable mixture had a very well accepted score on the basis of sensory attributes with reference to the concentration of 10 %.

In another study conducted by Bhavana *et al.* (2014) in an effort to formulate methi paratha to evaluate organoleptically by chronic kidney disease patients found that it was highly acceptable by 5 point hedonic scale rating. Though methi gives slightly bitter taste, yet it was accepted by the renal patients who were on dialysis.

Nwakalor *et al.* (2014) in his experimentation in incorporating *Moringa oleifera* leaf flour into wheat cookies in the ratio of 100:0,90:10,80:20,70:30,50:50 found that sensory general acceptability score was the best for cookies added with 10 and 20 levels. Similarly incorporation of 20g and 30g of *Tribulus terrestris* fruit powder respectively into the same recipe too did not attract and also the score was very poor in the present study. On the whole which suggest that this herb *Tribulus terrestris* (L) fruit powder may well be used in the food

preparation and readily be served to the needy. Therefore, this herb may be promoted by the health professionals among public to prevent or manage above mentioned diseases. As a food containing such a remedial therapeutic agent will be highly acceptable and will be helpful alleviating specific disease conditions.

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