

## Application of *Cissus quadrangularis* Linn. (*Hadjor*) in Nutraceutical Food (Bakery) Products

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**Abstract:** *Cissus quadrangularis* Linn. belongs to the family Vitaceae. It is a wild indigenous medicinal plant found in India, locally known as *Hadjor*. The importance of *Cissus quadrangularis* in regeneration of connective tissues involved in the bone healing process has been known since ages. The research work under taken has aim of nutraceutical products development and standardising, such as biscuits and cookies as per the FPO specifications. Biscuits were prepared contain RF dried hadjor powder in 5%, 10%, and 15% on 100% maida basis. Similarly Cookies were prepared using *hadjor* extract is Ghee. Nutrient composition of RF dried *Cissus quadrangularis* stem shows (1.451) phytosterols, (0.212)Ascorbic acid, (0.488)Phenols, (9.03)Calcite, (0.205)Iron, (0.175) Selenium (g/100g) on dry weight basis. Developed products were evaluated for sensory and chemical attributes. The 10% incorporation of hadjor powder in biscuits was scored highest in all respect of sensory attributes, with slight throat irritation. Cookies with 10% hadjor powder extract was also accepted in sensory analysis by trained panelist.

**Keywords:** hadjor, bone healer, nutraceutical products.

### Introduction:

Medicinal plants and herbs are of great importance to the health of the individuals and communities. A scientific investigation of traditional herbal remedies for several diseases may provide valuable lead for the development of alternative drug and therapeutic strategies. Since the consumption of medicinal plants is increasing, it is interesting to use these plants as a supplement in food taking into account that these plants can present a significant amount of trace elements (Alves, 2000; Correa, 1984; Andrade *et al.*(2005a and 2005b)<sup>3,4,5,14</sup> and other nutrients. Studies have been carried out by several workers on pharmacological properties of *Cissus quadrangularis* and revealed that it is useful in bone fractures (Singh and Udupa, 1962; Udupa and Prasad, 1964; and Chopra *et al.* 1976)<sup>13,36</sup>, obesity (Oben *et al.*, 2006)<sup>29</sup> and neuropharmacological effects (Viswanatha Swamy *et al.*, 2006)<sup>41</sup>. The literature reports also indicate the antibacterial activity (Kashikar and George, 2006)<sup>24</sup>, antioxidant activity (Chidambara Mrthy *et al.* 2003; Jainu and Devi, 2006)<sup>23</sup>, antiulcer activity (Jainu *et al.*, 2006)<sup>23</sup>, analgesis and anti-inflammatory (Shirwaikar *et al.*, 2003; Deka *et al.*, 1994; Panthong, 2006)<sup>15,32,35</sup>, antiosteoporotic (Shirwaikar *et al.*, 2003)<sup>35</sup>, proteolytic (Bah *et al.*, 2006a and Bah *et al.*, 2006b)<sup>10,11</sup>, mutagenetic (Sivaswamy *et al.*, 1991)<sup>38</sup> and genotoxic activity (Balachandran *et al.* 1991)<sup>12</sup>.

*Cissus quadrangularis* Linn. belongs to the family Vitaceae. It is a wild indigenous medicinal plant found in India, locally known as *Hadjor*. It is also found in other neighbouring countries like South Africa, Srilanka, Pakistan, Bangladesh, Malaysia, Thailand, Java and Philippines. It is mostly available in forest areas of Central India and some regions of the world due to recognition of its medicinal properties and due to its demand as a medicine it is now being cultivated. Commercial cultivation is done in some parts of South India. It is a common perennial climber, fleshy, cactus-like herb. Stem slender dichotomously branched, sub-angular, glabrous, brown, fleshy, fibrous with four-winged internodes and a leaf- opposed, persistent tendril at some nodes, aerial roots developing during the rainy season, leafless when old, 5-15 cm long, leaves cordate, broadly ovate or reniform, crenate-serrate, sometimes 3-7 lobed, glabrous, flowers small, greenish white, in short umbellate cymes. The importance of *Cissus quadrangularis* in regeneration of connective tissues involved in the bone healing process has been known since ages. It also helps in muscle building. It is used for centuries by traditional healers to treat bone fractures, stomach ailments, digestive problems and ear and eye diseases. It is also listed by the USDA (U.S. Department of Agriculture) as an edible vegetable (Facciola, 1990)<sup>17</sup>. It naturally contains a high amount of vitamin C, carotene A, phytosterols, calcium and trace elements viz. selenium, manganese, zinc and iron. All these active compounds have a synergistic effect on bone fracture healing process.

Extensive work has been reported on the edibility of *Cissus quadrangularis* stem. The stout fleshy quadrangular stem of *Cissus quadrangularis* is an edible plant found throughout the hotter parts of India, Malaya, West Africa & Ceylon (Udupa *et al.*, 1970)<sup>40</sup>. Young stems made into curries and chutneys (Anon, 1992)<sup>6</sup>. *Cissus quadrangularis* L. is used as a common food item in India (Sivarajan and Balachandran, 1994)<sup>37</sup>. The stem pulp of *Cissus quadrangularis* L. (Vitaceae) a commonly consumed diet in India has been used for fracture healing, eye diseases, chronic ulcers, tumors, asthma and piles (Asolkar, *et al.*, 1997)<sup>8</sup>. The tender shoots and young leaves are used in various food preparations. The juice of the plant is said to be beneficial in scurvy (Kirtikar and Basu, 2000)<sup>25</sup>. According to (Oudhia, 2005)<sup>31</sup> sweet dish *halwa* is prepared from fleshy stem by the tribal population in Chhattisgarh region. A paste of the whole plant is taken for improving the digestion and inducing appetite. *Allium sativum* + *Cissus quadrangularis* + *Capsicum frutescens*: These three plants are made into a green salad and taken for gas trouble (Ganesan *et al.*, 2007)<sup>19</sup>. Jainu *et al.* (2006)<sup>23</sup> reported the plant to be used as a common food supplement in Southern India. The tender stem and leaves possess a spicy taste and hot nature. In South India, *vathal* and *thuvayal* are the two most common preparations. They are made into pickles or chutneys and consumed with other foods. The mature stems are cut into small pieces and soaked in butter milk. The desired quantity of salt is added and the mixture is dried in sunlight by which *vathal* is prepared and stored properly. When required the *vathal* is fried in oil and when consumed it is helpful for indigestion and tastelessness. For *thuvayal* preparation, the stem is collected fresh, the outer skin is removed and the stems are cut into small pieces. They are then fried in ghee, a pinch of tamarind, salt and chilly are added and the mixture is ground to fine paste. Final frying should be done with black gram and mustard and kept in an airtight container. This preparation is mixed with cooked rice and sesame oil and consumed. It can also be served as a side dish for *idlies* and *dosa*. This preparation helps to cure indigestion, gas troubles and promotes the strength of the bones and nerves. It can be regularly given to children to strength the bones ([www.geocities.com/tamildictionary/herbs/TAMILHERBS.pdf](http://www.geocities.com/tamildictionary/herbs/TAMILHERBS.pdf))<sup>42</sup>. Attawish *et al.* (2002)<sup>9</sup> conducted toxicological evaluation of *Cissus quadrangularis* L. and revealed that the drug is safe and energetic even at higher dose for a prolonged duration of treatment.

Even though the plant is rich in medicinal properties it remains underutilized due to lack of awareness and unavailability of raw material in easy consumable forms. Presence of high amount of oxalate is the basic hurdle in consumption of fresh plant. Due to non acceptability of taste in their original form, it is not possible to continue the intake of these medicinal plants for longer period.

To explore its utilization, efforts are needed for development of nutraceutical food products using these traditional medicinal plants so that they can be incorporated in the diets of common man. Considering the therapeutic potential of the plant, it is believed that their use as nutraceutical supplements is interesting<sup>16</sup>.

Biscuits are the most popular bakery items consumed nearly by all sections of the society in India. Some of the reasons for such wide popularity are low cost in compared with other processed foods, good nutritional quality and availability in different forms, varied taste and longer shelf life. Bakery products are sometimes used as a vehicle for incorporation of different nutritionally rich ingredients (Gandhi *et al.*, 2001; Sudha *et al.*, 2007)<sup>18,33</sup>. Information on incorporation of *Cissus quadrangularis* stem powder in bakery products is scanty. Hence, development and consumption of such therapeutic bakery products would help to raise the nutritional status of population (Shalini and Sudesh, 2005b)<sup>34</sup>.

Therefore, in view of above objective, nutraceutical products such as biscuits and cookies have been developed and standardized as per the FPO specifications. Developed products were also evaluated for sensory and chemical attributes.

### **Materials and Methods:**

#### **Materials:**

*Cissus quadrangularis* stem was obtained from Centre for Forestry Research and Human Resource Development, Chhindwara. Maida and other ingredients were obtained from the local market.

#### **Methods:**

- 1. Processing:** For preparation of *Cissus quadrangularis* (*Hadjor*) stem powder, the stem was cut into 10mm thick pieces and dried using a Radio frequency (RF) drier at 50°C under hot air convection. The dried pieces were ground and sieved to obtain fine powder. This powder was then used directly for the preparation of biscuits and cookies.
- 2. Preparation of flour mixtures:** Radio frequency (RF) dried *Cissus quadrangularis* (*Hadjor*) stem powder at different ratios of 5%, 10% and 15% was well blended with maida and then prepared mixtures were used to manufacture biscuits. The biscuits were formulated on 100% maida basis. Cookies were prepared using *hadjor* extract is Ghee. Extract was prepared by boiling *hadjor* powder with 60gm of Ghee. Again 5%, 10% and 15% *hadjor* powder was used for preparation of extract and used for preparation of cookies. Cookies were formulated on 100% *maida* basis.
- 3. Preparation and evaluation of biscuits:** Biscuits and cookies were prepared according to the method described in A. A. C.C, 2000<sup>1</sup>. Organoleptic characteristics of biscuits were evaluated by 9 point hedonic scale sensory method with trained panellists. The tested characteristics were colour, texture, taste, after taste, throat irritation, mouth feel and overall acceptability.
- 4. Chemical Evaluation:** Fresh stem, radio frequency (RF) dried powder, 10% RF dried powder extract in water, 10% RF dried powder extract in ghee and prepared biscuits and cookies were chemically analysed for the active ingredients of medicinal importance (calcite, phytosterols, ascorbic acid & phenols) and appropriate dosage decided as per the recommended daily consumption limits from the literature. Ascorbic acid content was estimated by the titrimetric method of Aberg (1958)<sup>2</sup>. Total phenol content in the sample was estimated by Folin-Ciocalteu reagent (Malick and Singh, 1980)<sup>28</sup>. Calcium was estimated by titrimetric method according to the procedure of Association of Official Analytical Chemists (AOAC, 1970)<sup>7</sup>. Total phytosterols were estimated by Harborne method (1998)<sup>20</sup>.
- 5. Colour:** Colour of biscuits and cookies was measured by using a spectro-colorimeter with CIF lab colour scale. .
- 6. Sensory evaluation:** Sensory evaluation of biscuits and cookies was performed and formulation was standardized to determine the most acceptable *Hadjor* concentration. Biscuits and cookies were evaluated for surface colour, taste, texture, after taste, throat irritation, mouth feel and overall acceptability on a 9-point hedonic scale by a panel of 12 judges which includes 6 male judges and 6 female judges.
- 7. Statistical analysis :** Data of organoleptic evaluation of biscuits and cookies were subjected to analysis of variance and least significant difference (L.S.D.) at 0.05 level according to the method of T test. Data of biochemical parameters were performed by two-way analysis of variance and test significant difference tests (ANOVA).

### **Results and Discussion:**

The fresh plant, radio frequency dried powder (yield of dried powder is 120g/1000gm of fresh herb), extract with water and extract with ghee were evaluated for chemical components having medicinal and nutritional importance viz. phytosterols, phenols, ascorbic acid and calcite. The results obtained are depicted in Table1.

**Table1: Nutrient composition of *Cissus quadrangularis* stem and extracts**

Parameters	Phytosterols (g/100g)	Ascorbic acid (g/100g)	Phenols (g/100g)	Calcite (g/100g)	Iron (g/100g)	Selenium (g/100g)
Fresh stem	1.8552 ±0.031	0.9505±0.04	0.648±0.033	11.12±0.031	0.25±0.048	0.21±0.053
RF Dried powder	1.451±0.039	0.212±0.036	0.488±0.045	9.03±0.047	0.205±0.051	0.175±0.028
10% RF dried powder Extract in water	0.04±0.052	0.135±0.029	0.322±0.041	6.7±0.0412	0.185±0.05	0.091±0.044
10% RF dried powder Extract in ghee(g/60 gm)	0.1024±0.0451	0.0085±0.02	0.03311±0.039	0.09±0.049	-	-

It is clear that radio frequency dried powder (yield of dried powder is 120g/1000gm of fresh herb), extract with water and extract with ghee are a good potential source for phytosterols, ascorbic acid, phenols, calcium, iron and selenium.

### Sensory evaluation of biscuits and cookies:

The effect of different ratios of 5%, 10% and 15% of radio frequency dried powder blended with maida were used to manufacture biscuits and cookies and were evaluated sensorial and the results obtained are depicted in Table 2 (biscuits) and 3 (cookies) respectively.

**Table 2 : Sensory attributes for Biscuits**

Parameters	A (05% hadjor powder)	B (10% hadjor powder)	C (15% hadjor powder)
Texture	Crispy with uniform layered & grain structure	Crispy with uniform layered & grain structure	Crispy with uniform layered & grain structure
Colour	Uniform brown with a green grains	Uniform brown with a green grains	Uniform brown with fairly green grains
Taste	Baked with slight herb taste	Baked with moderate herb taste	Baked with prominent herb taste
After taste	Regular baked	Regular baked	Regular baked with slight herby
Throat irritation	No irritation	Slight irritation	Prominent irritation
Mouth feel	Smooth, greasy feel	Moderately dry	Parched

In the biscuit formulation, the sensory score for colour, taste, after taste, throat irritation and mouth feel increased sharply with increase in the concentration of *Cissus quadrangularis* powder. Formulation with 15% *Cissus quadrangularis* powder impaired the taste, after taste, throat irritation and mouth feel of biscuits and had score. Biscuits made from blends containing 5% and 10% level of addition has slight throat irritation along with good colour, taste and mouth feel which has been accepted by sensory panellist significantly ( $p < 0.05$ ) from the control.

**Table 3: Sensory attributes for Cookies**

Parameters	A (5% powder extract in ghee)	B (10% powder extract in ghee)	C (15% powder extract in ghee)
Texture	Crispy with uniform layered & grain structure	Crispy with uniform layered & grain structure	Crispy with uniform layered & grain structure
Colour	Uniform brown with slight green	Uniform greenish brown	Uniform brown with fairly green
Taste	Pleasant, sweet, typical of Baked product	Pleasant, sweet, typical of Baked product	Pleasant, sweet, typical of Baked product with slight herby
After taste	Regular baked	Regular baked	Regular baked with slight herby
Throat irritation	No irritation	No irritation	Slight irritation
Mouth feel	Smooth, greasy feel	Smooth, greasy feel	Smooth, greasy feel

Table 4: Sensory Score for Biscuits and Cookies

Parameters	Biscuits			Cookies		
	5%	10%	15%	5%	10%	15%
Texture	7±0.04	8±0.04	8±0.022	9±0.046	9±0.04	9±0.04
Colour	9±0.045	8±0.036	7±0.019	9±0.041	9±0.033	8±0.04
Taste	8±0.043	7±0.041	5±0.037	8±0.028	8±0.026	8±0.034
After taste	7±0.039	7±0.04	6±0.052	8±0.039	8±0.029	7±0.047
Throat irritation	6±0.021	6±0.037	4±0.028	9±0.035	9±0.031	8±0.035
Mouth feel	8±0.032	8±0.035	6±0.021	8±0.027	8±0.02	8±0.025

Comparison of concentration of active ingredients in Radio Frequency dried powder and extracts on g/100g basis is shown graphically (Figure 1), nutrient contents of biscuits (Fig. 2), and cookies (Fig. 3).

### Discussion:

Oliveira *et al.* (2009)<sup>30</sup> reported development of gluten-free cookies from *Paullinea cupana* (guarana) and *Anemopaegma mirandum* (Catuaba) medicinal plants aiming at copper, iron and zinc supplementation. Sensorial tests indicated that the cookies presented good acceptance with potential to sensorial growth. Hussain *et al.* (2011)<sup>21</sup> studied the physiochemical, sensory and nutritional properties of corn-fenugreek flour composite biscuits and confirmed that fenugreek flour could be incorporated upto 10% level in the formulation of biscuits without affecting their overall quality. Ibrahim and Hegazy (2009)<sup>22</sup> studied iron availability of wheat biscuit supplemented by fenugreek seed flour and concluded that 10% germinated fenugreek seed flours into wheat biscuits considerably improved bioavailability of fenugreek seedflour biscuit iron.

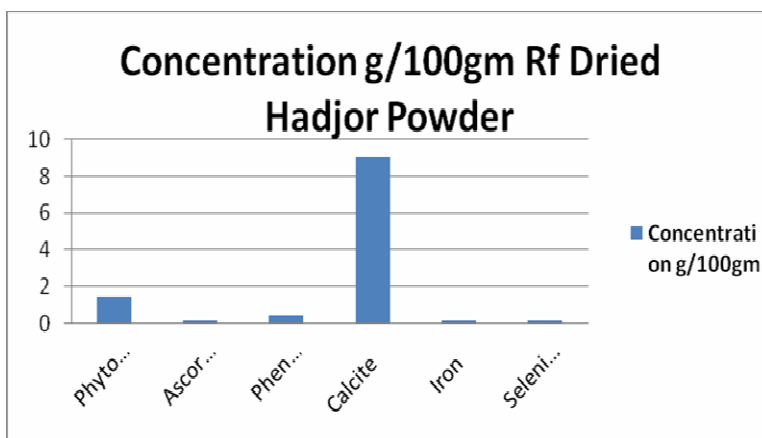


Fig.1: Comparison of concentration of active ingredients in Radio Frequency dried powder and extracts on g/100g basis.

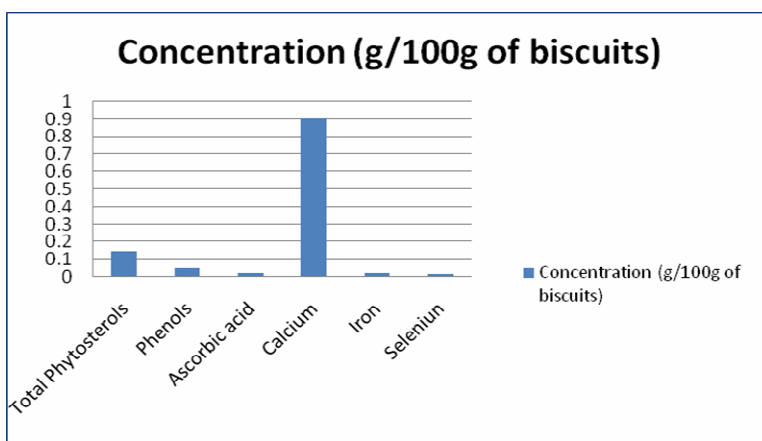


Fig.2: Nutrient contents of *Cissus quadrangularis* biscuits

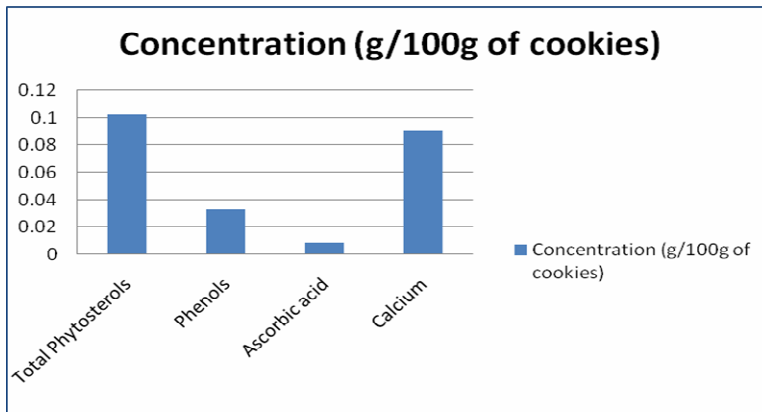


Fig.3: Nutrient contents of *Cissus quadrangularis* cookies

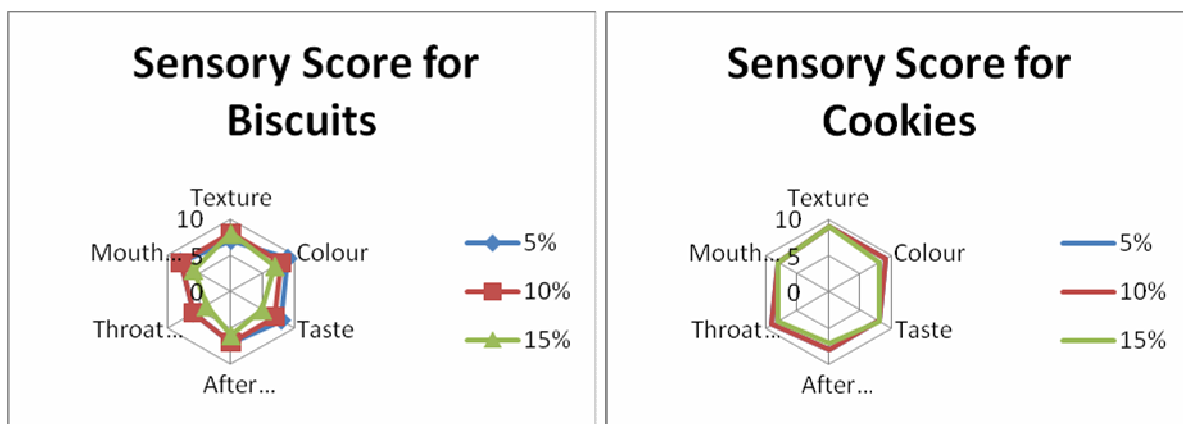


Fig. 4: Comparison of Sensory Score for Biscuits and Cookies

The cookies produced in the present study can be considered good sources of phytosterols, polyphenols, ascorbic acid, calcium, iron and selenium. Furthermore they are beneficial to people affected by any bone related problems. They also present functional properties.

### **Conclusion:**

The biscuits and cookies developed in this study presented good acceptance among consumers. They present satisfactory amounts of antioxidant constituents viz. phenols, ascorbic acid and phytosterols and minerals calcium, iron and selenium acting as important assistants in the supplementation of each of these minerals. Sample B (10% of RF Dried powder) biscuits were found most acceptable. As the biscuits contain RF dried powder in whole form the active ingredients in product can directly be estimated as in the powder except for slight losses in vitamins and volatile phenols during baking (at 180°C). Higher percentage of *hadjor* powder tends to cause throat irritation in sensitive individuals and parched mouth feel. Hence it is not acceptable. Cookies made using 10% powder extract in ghee (sample B) were found most acceptable due to its pleasant colour, taste and absence of throat irritation. Sample C can also be used with a precaution of throat irritation in sensitive individuals. The chemical analysis of the extract in ghee can be used to estimate its medicinal benefits.

### **References:**

1. A.A.C.C. 2000. Approved method of the AACC. 10<sup>th</sup> ed., American Association of Cereal Chemists, INC. St. Paul, Minnesota, USA.
2. Aberg, 1958. Ascorbic acid in, Encyclopedia of Plant Physiology,6,479-(ed. Burstorn, H.) Springer-Verlag, Berlin.
3. Alves, T.M. et al. 2000. Biological screening of Brazillian medicinal plants.Memorias do Instituto Oswaldo Cruz. 95:3, 367-373.
4. Andrade, E.C.B., Alves, S.P. and Takase, I. 2005a. Evaluation of the use of medicinal grass as nutritional supplement of iron, copper and zinc. Ciencia e Tecnologia de Alimentos, 25:3, 591-596.

5. Andrade, E.C.B., Alves, S.P. and Takase, I. 2005b. Sequential extraction of copper, iron and zinc in medicinal plants. *Ciencia e Tecnologia de Alimentos*, 25:4, 844-848.
6. Anon, 1992. *The Wealth of India*, C, Council of Scientific & Industrial Research, Publication and Information Directorate, New Delhi.
7. A.O.A.C.1970. Association of Official Agricultural Chemists, "Official Methods of Analysis," 12<sup>th</sup> ed, Washington D.C.
8. Asolkar, L.V., Kakkar, K.K., Chakre, O.J. 1997. *Glossary of Indian Medicinal Plants with active principles*. CSIR Publication, New Delhi, 145-150.
9. Attawish, A., Chavalttumorong, D., Chivapat, S., Chuthaputti, S., Rattarajarasroj, S., Punyamong, S. 2002. Subchronic toxicity of *Cissus quadrangularis* Linn. *Songklanakarin. Journal of Sci. Tech.*, 24, 39-51.
10. Bah, S.D., Dillo, and Paulsen, B.S. 2006a. Ethnopharmacological survey of plants used for the treatment of schistosomiasis in Niono District, Mali. *J. Ethnopharmacol.*, 105:387-399.
11. Bah, S., Paulsen, B.S., Diallo, D., and Johansen, H.T. 2006b. Characterization of cysteine proteases in Malian medicinal plants. *J. Ethnopharmacol.*, 107:189-198.
12. Balachandran, B., Sivaswamy, S.N., and Sivaramakrishnan, V.M. 1991. Genotoxic effects of some foods and food component in Swiss mice. *Ind. J. Med. Res.*, 94:378-383.
13. Chopra, S. S., Patel, M. R., and Awadhiya, R. P., 1976. Studies of *Cissus quadrangularis* in experimental fracture repair: a histopathological study. *Indian J. Med. Res.*, 1976, 64, 1365-1368.
14. Correa, M.P. 1984. *Dicionario das plantas uteis do Brasil e das exoticas cultivadas*. Rio de Janerio: Instituto Brasileiro de Desenvolvimento Florestal.
15. Deka, D. K., Lahon, L. C., Saikia, J. and Mukit, A. 1994. Effect of *Cissus quadrangularis* in accelerating healing process of experimentally fractured radius-ulna of dog: A preliminary study. *Indian J.Pharmacol*, 26, 44-45.
16. Enechi, O. C. and Odonwodo, I. 2003. An assessment of the phytochemical and nutrient composition of the pulverized root of *Cissus quadrangularis*. *Bio-Research*, 1, 63-68.
17. Facciola, S. 1990. *Cornucopia, a source book of edible plants*, Kampong Publications.(<http://www.ars-grin.gov/cgi-bin/npgs/html/taxon.pl?10622>).
18. Gandhi, A., Kotwaliwale, N., Kawalkar, J., Srivastava, D., Parihar, V. and Raghu Nadh, P. 2001. Effect of incorporation of defatted soy flour on the quality of sweet biscuits. *J. Food Sci. Technol.*, 38:502-503.
19. Ganesan, S., Raman Pandi, N., and Banumathy, N. 2007. Ethnomedicinal survey of Alagarkoil hills (Reserves forests) Tamil Nadu, India. *Electronic Journal of Indian Medicine*, 1: 1-19.
20. Harborne, J.B. 1998. *Phytochemical Methods: A guide to modern techniques of plant analysis*. 3<sup>rd</sup> edition, Chapman & Hall, London.
21. Hussain, A.M.S., Azeem, A., Hegazy, Afifi, A.A. and Ragab, G.H. 2011. Phytochemical, sensory and nutritional properties of corn-fenugreek flour composite biscuits. *Australian Journal of basic and Applied Sciences*, 5:4, 84-95.
22. Ibrahim, M.I. and Hegazy, A.I. 2009. Iron availability of Wheat biscuit supplemented by fenugreek seed flour. *World Journal of Agricultural sciences* 5:6, 769-776.
23. Jainu, M.K., Vijai Mohan and C.S.S. Devi. 2006. Protective effect of *Cissus quadrangularis* on neutrophil mediated tissue injury induced by aspirin in rats. *Journal of Ethnopharmacology*, 104: 302-305.
24. Kashikar, N.D., and George, I. 2006. Antibacterial activity of *Cissus quadrangularis* Linn. *Indian Journal of Pharmaceutical Sciences*, 68(2):245-247.
25. Kirtikar, K.R., Basu, B.D. 2000. *Indian Medicinal Plants*, 3<sup>rd</sup> revised and enlarged ed., By Basu, I.M., Allahabad, India, 841-843.
26. Sivarajan, V.V., Balachandran, I. 1994. *Ayurvedic drugs and their plant sources*. Oxford and Indian Book Publishing Co. Pvt. Ltd., New Delhi.
27. *Edible Plants of the Tropical Dry evergreen forests*. 2007. Draft concept plans for discussion, 2007.
28. Malick, C.P., and Singh, M.B. 1980. In: *Plant Enzymology and Histo-Enzymology* Kalyani Publishers, New Delhi, 286.
29. Oben, J, Kuate, D., Agbor, G., Momo, C., and Talla, X. 2006. The use of a *Cissus quadrangularis* formulation in the management of weight loss and metabolic syndrome. *Lipids Health Dis.*, 2:24.

30. Oliveira, K.E., Takase, I. and Goncalves, E. 2009. Development of gluten free cookie from medicinal plants *Paullinea cupana* (guarana) and *Anemopaegma mirandum* (Catuaba) aiming at copper, iron and zinc supplementation.
31. Oudhia, P. 2005. A case study report on *Cissus quadrangularis* Linn. website:[www.botanicals.com](http://www.botanicals.com)
32. Panthong, A.W., Supraditaporn, D., Kajanapothi, T., Taesotikul, and Reutrakul, V. 2006. Analgesic, anti-inflammatory and venotonic effects of *Cissus quadrangularis* *Ethnopharmacol*, 110: 264-270.
33. Sudha, M., Vetrmani, R. and Leelavathi, K. 2007. Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. *Food Chem.*,100: 1365-1370.
34. Shalini, H. and Sudesh, J. 2005b. Effect of fenugreek flour blending on physical, organoleptic and chemical characteristics of wheat bread. *Nutrition and Food Sci.*, 35: 229-242.
35. Shirwaikar A, Khan S, Malini S. 2003, Antiosteoporotic effect of ethanol extract of *Cissus quadrangularis* Linn. on ovariectomized rat. *J Ethnopharmacol*, 89 (2-3): 245-250.
36. Singh, L.M. and Udupa, K.N. 1962. Studies on *Cissus quadrangularis* in fracture by using phosphorus 32: part II. *Indian J Med. Sci.* 16:926-931.
37. Sivarajan, V.V., Balachandran, I. 1994. *Ayurvedic drugs and their plant sources*. New Delhi. Oxford and Indian Book Publishing Co. Pvt. Ltd.
38. Sivaswamy, S. N., Balachandra, B., Balanehru, S., and Sivaramakrishnan, V. M. 1991. Mutagenic activity of south Indian food items. *Indian J. Exp. Biol.*,29: 730-737.
39. Udupa, K. N. and Prasad, G. C. 1964. Further studies on the effect of *Cissus quadrangularis* in accelerating fracture healing. *Indian J Med. Res.*, 52, 26-35.
40. Udupa, K.N., Chaturvedi, G.N., Tripathi, S.N. 1970. *Advances in research in Indian medicine*, vol. 12, Varanasi, Banaras Hindu University.
41. Viswanatha Swamy, A.H.M., Thippeswamy, A.H.M., Manjula, D.V. and Mahendra Kumar, C.B. 2006. Some neuropharmacological effects of the methanolic root extracts of *Cissus quadrangularis* in mice. *African J. Biomedical Research*, 9:2, 69-75.

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