



Research Paper

Development of a sauce using *Gymnema sylvestre* leaves

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Article History:

Received: 26 January 2017

Revised form received: 28 June 2017

Accepted: 30 June 2017

Abstract: Plant derived products have attracted enormous attention due to their diverse range of biological and therapeutic properties. *Gymnema sylvestre* is an underutilized medicinal herb, widely distributed in different parts of the world. It is rich in phytochemicals with anti-diabetic and anti-obesity properties. However, the herb is less popular due to its bitter taste.

This study was focused to develop a sauce using leaves of *G. sylvestre*. The most acceptable composition (17.2% water, 4.8% vinegar, 3.2% sweet potato, 2.6% chili, 2.0% sugar, 2.0% cinnamon, 2.0% cardamom, 1.8% ginger, 1.8% garlic, 1.2% onion, 1.2% salt, 0.1% citric acid and 0.1% sodium benzoate) of the sauce was with 60% leaf extract. The final product contained $73.54\% \pm 1.68$ moisture, $19.92\% \pm 2.59$ carbohydrates, $2.98\% \pm 0.44$ ash, $2.61\% \pm 0.58$ protein, $0.88\% \pm 0.05$ fiber and $0.05\% \pm 0.01$ fat. The total flavonoid content of the product was 243.67 ± 8.57 μ moles of rutin equivalent and the total phenolic content was 65.44 ± 0.51 μ moles of gallic acid equivalent. Inhibition of DPPH % of the total antioxidant capacity was 43.70 ± 0.72 . Sauce formulated with 1000 ppm sodium benzoate showed six weeks of shelf life. The results revealed that development of a sauce from *G. sylvestre* leaves is an effective way of delivering its health benefits to the potential consumers.

Keywords: *Anti-diabetic, Anti-obesity, Functional food, Gymnema sylvestre*



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Introduction

Current trend of the food industry is for quick, easy and convenient products. Therefore, fast foods are in high demand. Sauce has become a popular food product among people owing to the increased consumption of fast food. It is one of the instant side dishes, which is used for dipping or used as a condiment. Mostly, sauces are with low nutritional value, high sodium and calorie content. However, high consumption of fast food leads to health problems (Ashakiran and Deepthi, 2012; Harris *et al.*, 2013). It is evident that plant-based

diets can reduce the risk of chronic diseases and promote sound human health as they carry functional foods containing physiologically active components (Ashwell, 2001).

Gymnema sylvestre (R. Br.) is a dicotyledonous medicinal herb belonging to the family Asclepiadaceae, and is known as “Masbadda” in Sinhala and “Chirukurinja” in Tamil (Ahmed *et al.*, 2010; Fabio *et al.*, 2013). The plant is well known for its sweet taste-suppressing activity, and is

useful for treatment of diabetes mellitus and obesity (Thakur *et al.*, 2012; Krishna *et al.*, 2012). It is used as a substance having stomachic, diuretic, anti emetic and antiviral effects, and also showing inhibited absorption of glucose in the small intestine and inhibitory action against glucan synthesis (Shanmugasundaram *et al.*, 1990; Bone, 2002; Sanej *et al.*, 2010). The leaves of *G.*

Materials and Methods

This study consisted of four phases. During the first phase, four sauce formulations were prepared using 50, 60, 70 and 80% (w/w) concentrations of leaf extract. The second phase of the experiment was conducted to determine the better thickening agents between sweet potato flour and pumpkin flour. The final two phases were the preparation of sauce and evaluation of physico-chemical characteristics of the final product.

Preparation of sauce

The leaf extract of *G. sylvestre* was boiled with continuous stirring at 55 to 60 °C for 2-3 min, and then sweet potato flour was added before heating up to 65 °C with continuous stirring. Thereafter, salt, sugar, vinegar, citric acid and spices were added and mixed while boiling. Sodium benzoate (1000 ppm) was then added to the boiling mix, and kept on boiling at 65 to 70 °C with continuous stirring to reach 25° brix. The final product was immediately transferred into sterilized clean glass bottles, sealed and stored at room temperature.

Sensory evaluation

Sensory evaluation was done by simple ranking test with five-point hedonic scale. The sensory attributes (color, odor, taste, appearance, texture and overall acceptability) were evaluated by 15 untrained panelists.

Results and Discussion

Sensory evaluation

Sensory evaluation done for the selection of appropriate leaf extract (Figure 1) showed that sauce formulated using 60% extract receiving the highest median score for overall acceptability. Owing to high chlorophyll content, the color of the sauce stronger with increasing concentration of

sylvestre exhibit several functional properties. However, direct consumption of leaves is challenging due to the bitter and astringent taste. Hence, products based on *G. sylvestre* are rare in the market (Kumar, 2015). Therefore, this study was focused on to developing a novel functional food product from *G. sylvestre* leaves, in order to pass the health benefits to fast food consumers.

Proximate analysis

To determine the nutritional content of sauce and leaves, the proximate composition (moisture, ash, fat, protein, total fiber and carbohydrate content) was evaluated according to AOAC (2000).

Evaluation of functional properties

Phenolic content, flavonoids and antioxidant capacity were determined in leaves and sauce by Folin-Ciocalteu reagent method, aluminium chloride method and DPPH free radical scavenging activity, respectively (Maurya and Singh, 2010; Olajire and Azeez, 2011).

Evaluation of shelf life

The storage stability of sauce was determined by assessing the physico-chemical properties, including titratable acidity, pH, water activity and brix value at weekly intervals for six weeks (Chaturvedi *et al.*, 2013). Total plate count and yeast and mould counts were also evaluated during the storage period.

Statistical analysis

Non-parametric tests were used to analyse the results of sensory evaluations. Other parameters were tested for significance applying Analysis of Variance using Minitab and SPSS software packages at p=0.05.

the leaf extract. However, consumer preference for odor and taste has decreased with increasing concentration of the leaf extract due to the inherent leaf properties of *G. sylvestre* such as bitterness and astringent taste. Therefore, 60% leaf extract was effective for preparation of the sauce.

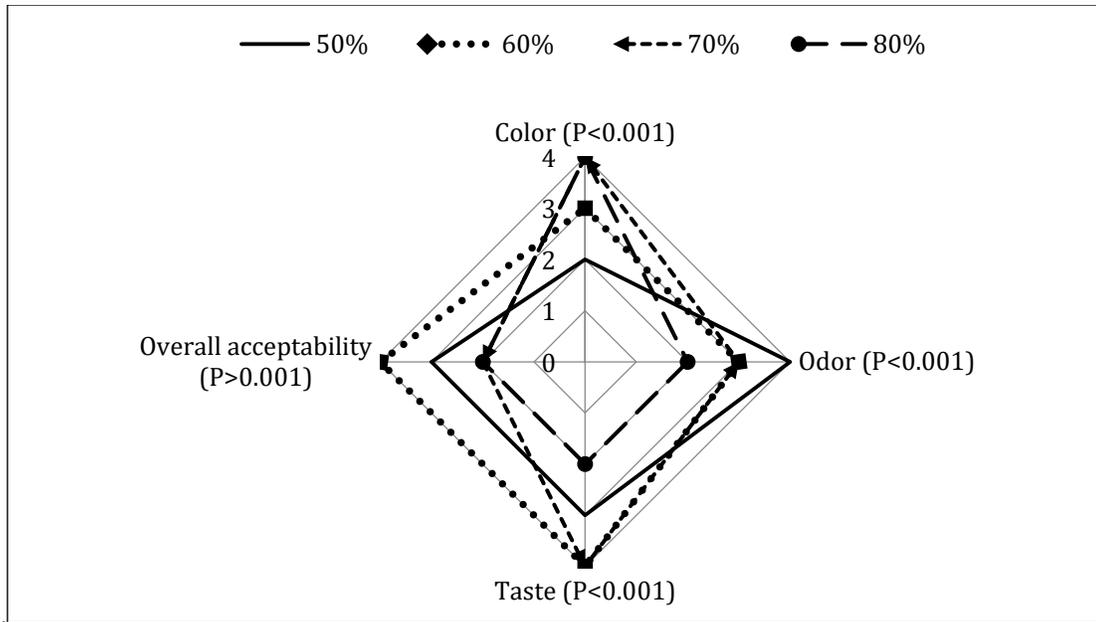


Figure 1. Spider web sensory analysis for sauce formulations with different concentrations of leaf extract

In general, sauces are thickened with starchy products such as wheat flour, corn starch, arrow root, bread crumbs, potato starch and rice flour. Nevertheless, some commercial products incorporate various other types of starches for thickening (Arocas *et al.*, 2009). Figure 2 illustrates that the product formulated with sweet potato flour has scored the highest median score for all the sensory attributes, except taste. Therefore, sweet potato flour was selected as a

better thickening agent for the sauce formulation. In the present study, natural food ingredients have been used as thickening agent to reach the target of improving the beneficial effect of the final product. Consumption of sweet potato provides pharmacological interventions on antidiabetic, antihypertensive, antioxidant, anti-inflammatory, and antimicrobial activities (Dutta, 2015; Mohanraj and Sivasankar, 2014).

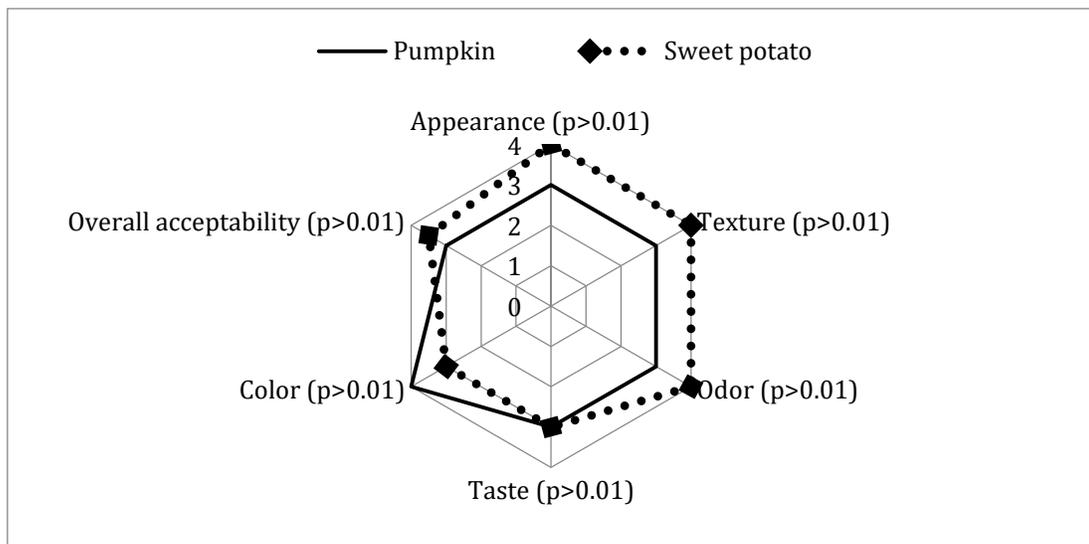


Figure 2. Spider web sensory analysis for sauce formulations with different thickening agents

Based on the results of sensory evaluations, the final formulation of *G. sylvestre* sauce was prepared with 60% leaf extract, 17.2% water, 4.8% vinegar, 3.2% sweet potato, 2.6% chili, 2.0% sugar, 2.0% cinnamon, 2.0% cardamom, 1.8% ginger, 1.8% garlic, 1.2% onion, 1.2% salt, 0.1% citric acid and 0.1% sodium benzoate.

Proximate analysis

Table 1 shows the nutritional value of sauce as depicted by proximate analysis. There was a significantly high amount of moisture content

in *G. sylvestre* leaves than that in the sauce. However, tomato sauce contains low moisture content (66.65%±0.14) compared to that observed in *G. sylvestre* sauce. This may be due to that the higher amount of total solids in the tomato pulp than that in *G. sylvestre* leaf extract. Sauce is generally considered as a low-fat product. For example, tomato sauce contains 0.62±0.01 fat (Akhtar *et al.*, 2009). Nevertheless, *G. sylvestre* sauce recorded a lower amount of fat compared to other sauces.

Table 1. The proximate composition of the *G. sylvestre* leaves and formulated sauce

Proximate value	Amount (g/100g wet basis)	
	<i>G. sylvestre</i> leaves	Sauce
Moisture	79.69 ± 1.78	73.54 ± 1.68
Total solids	20.31 ± 1.78	26.45 ± 1.68
Carbohydrate	7.17 ± 2.44	19.92 ± 2.59
Crude protein	10.29 ± 0.76	2.61 ± 0.58
Ash	2.04 ± 0.80	2.98 ± 0.44
Crude fiber	0.29 ± 0.01	0.88 ± 0.04
Crude fat	0.50 ± 0.14	0.05 ± 0.01

The values presented are Mean ± standard deviation of three independent determinations

Functional properties

Phytochemicals are rich in plant species. Hence, plant-derived products are considered as functional foods. Table 2 demonstrates that the newly developed sauce has high phenolic content and antioxidants compared to its leaf counterpart. During preparation of the sauce, several ingredients such as cinnamon, cardamom, ginger, garlic, onion and sweet potato were added and

many of which are rich sources of antioxidants due to the presence of various phenolic compounds (Chandersekara and Shahidi, 2010). The processing methods such as blending and heating may also enhance the phenolic content *via* increasing softening of the tissues and liberating the bound phenolic compounds, present in the cell matrix (Bembem and Sadana, 2013).

Table 2. Functional properties of the *G. sylvestre* leaf extract and sauce

Functional properties	Amount	
	<i>G. sylvestre</i> leaf extract	Sauce
Total antioxidant activity (% of Inhibition of DPPH)	24.15 ± 1.48	43.70 ± 0.72
Total Flavonoid (µ moles of Rutin Equivalent per ml of sample)	247.79 ± 6.26	243.67 ± 8.57
Total phenolic content (µ moles of Gallic Acid Equivalent per ml of sample)	52.48 ± 0.51	65.44 ± 0.51

The values presented are Mean ± standard deviation of three independent determinations

Physico-chemical properties

Table 3 shows the physico-chemical properties of the *G. sylvestre* sauce. According to SLSI standards, tomato sauce shall have a Brix value not be less than 25%, pH 4.6 and 0.8% titratable acidity. The

same standards were applied in preparation of the *G. sylvestre* sauce. Brix value of the sauce is influenced by the presence of sugar and sweet potato flour. The Food and Drug Administration Federal Agency in USA has reported that the pH

value of sauce should be within 4.4 to 5.4 (FDA, 2007). Further, according to the regulations, it is necessary to maintain a pH of 4.6 or less to preserve the product as production of botulism toxin by *Clostridium botulinum* is inhibited at this

pH range (Rahman and Thajudin, 2015). Hussain *et al.* (2008) reported that acidity is influenced by sodium benzoate, vinegar and citric acid in the mixture.

Table 3. Physico-chemical properties of the sauce formulated with *G. sylvestre* leaves

Properties	Value
Total Soluble Solids (Brix)	25°
pH	4.52 ± 0.01
Titrateable acidity (% of acetic acid equivalents)	0.82 ± 0.11
Water activity	0.77 ± 0.01

The values presented are Mean ± standard deviation of three independent determinations

Shelf life evaluation

Gymnema sylvestre sauce development study showed that there was an increasing number of bacteria, yeast and mold growth during the first six weeks of storage when product was stored in sterile bottles at room temperature (30±2 °C)(Figures 3 and 4). FDA (2013) has reported that the acceptable level of yeast and mold count of sauce is 100 CFU/g. Initially, the new sauce product was free from any microbial growth. *Aspergillus spp.* and *Penicillium spp.* are the two types of fungi that frequently grow on sauce owing to low pH or acidic medium needed for yeast and mold to promote sporulation. The range of acidic medium for the yeast and mold sporulation is pH 3

and above (Crues and Irish, 1932). Increasing microbial growth could be due to the low heating temperature (less than 75 °C) applied during the preparation of sauce. Therefore, spores of microbes may have remained after processing. At the same time, the temperature during storage, too, would have affected the growth of microorganisms, as theoretically, microorganism grows faster at temperatures 20 to 40 °C (Filtenborg *et al.*, 1996). Cross contamination from utensils or from handlers during the sauce preparation could be another possibility that would have resulted in an increase in microbial growth in the sauce product.

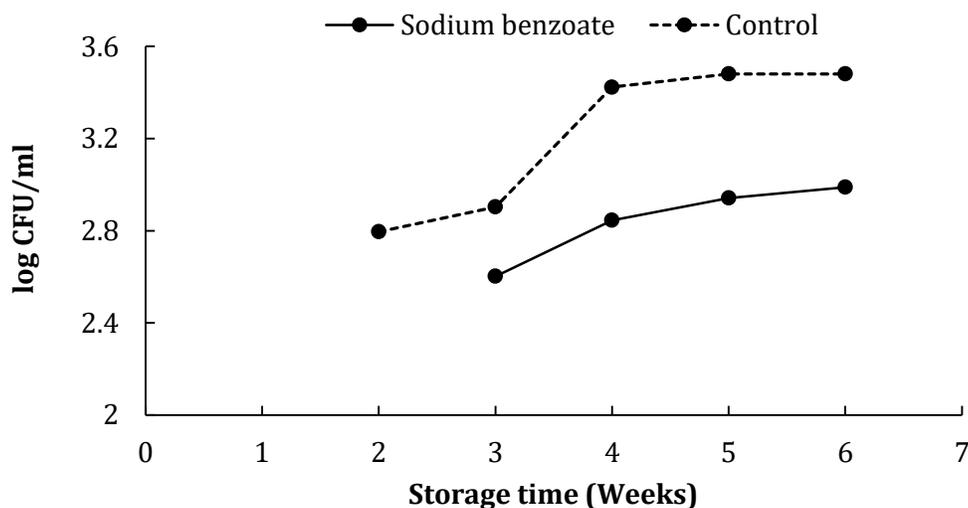


Figure 3. Changes of total plate counts in *G. sylvestre* sauce during storage

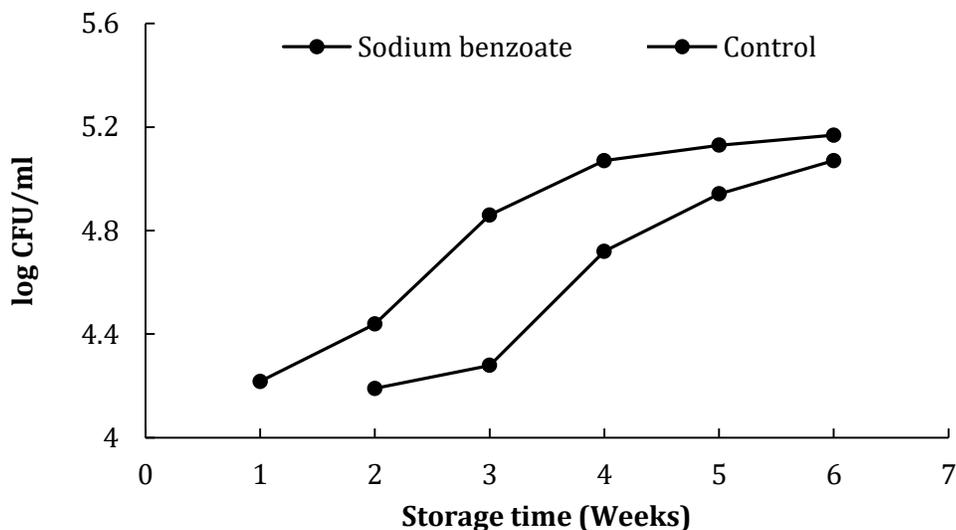


Figure 4. Changes of yeast and mold counts in *G. sylvestre* sauce during storage

Changes in the acidity of the sauce during storage for the first six weeks are illustrated in Figure 5. The influence of acidity by sodium benzoate, vinegar and citric acid may be a result of the

production of acid from polysaccharide degradation and sugar oxidation, or through breakdown of pectin molecule of the sauce.

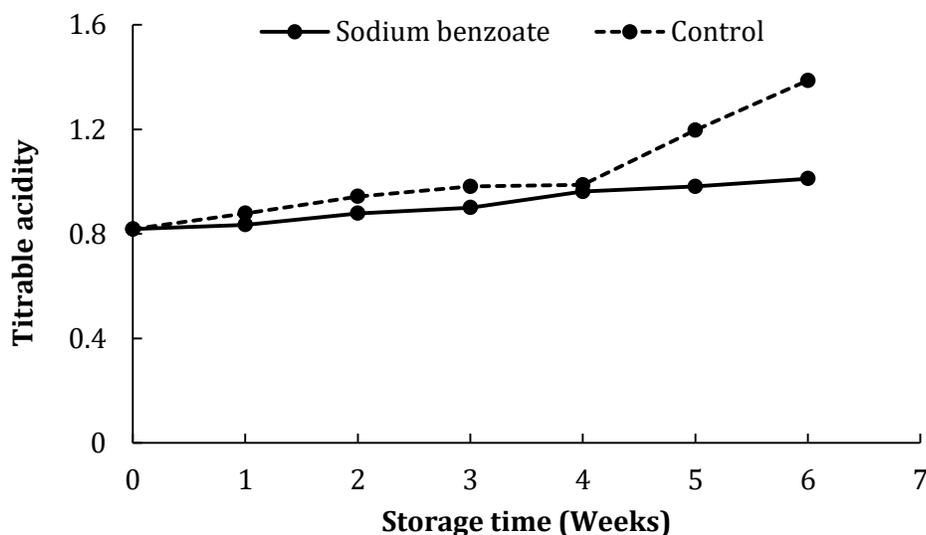


Figure 5. Changes of titratable acidity in sauce during storage

Preservatives are commonly used in almost all the processed food items in order to enhance the shelf-life and maintain the product quality. Sodium benzoate and sodium sorbate are most commonly used preservatives, which are

recommended by Sri Lanka standards. In this study, use of sodium benzoate as preservative on *G. sylvestre* sauce was effective in terms of retarding bacteria, yeast and mold. Theoretically, sodium benzoate is considered

as an agent that retard the growth of bacteria (*Bacillaceae*, *Enterobacteriaceae*), mold and yeast because benzoic acids is capable in

Conclusion

Gymnema sylvestre leaf extract can be used as an alternative ingredient for the production of sauce. The final sauce formulation selected with more than 70% preference for all the sensory attributes tested complies with the required Sri Lankan

preventing microorganism from using substances those are rich in energy for their growth (Losada, 2003).

Standards. The sauce with 1000 ppm sodium benzoate had six weeks of shelf life at room temperature. Further studies are recommended to verify the therapeutic effect of *G. sylvestre* sauce.

Competing Interest

All authors declare that there is no conflict of interest regarding the publication of this paper.

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