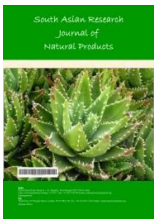

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Isolation and Characterization of Arabinoxylan from Leaves of *Neolitsea cassia* (L) Kosterm and Evaluation of Its Physicochemical and Functional Properties

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Authors' contributions

This work was carried out in collaboration between both authors. Author WSJ designed the study and performed the statistical analysis. Author WSJ wrote the first draft of the manuscript and managed the analyses of the study. Author KDPPG managed the literature searches and wrote the protocol. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: Arabinoxylan is a complex non-starchy polysaccharide classified under dietary fiber group which mainly contains the cell wall of the cereals. In the food industry, commercially available arabinoxylan is used as a gelling agent, thickener, stabilizer and emulsifier. Leaves of *Neolitsea cassia*, a native plant in Sri Lanka and gummy materials in its leaves used for the preparation of specific traditional sweet called "Asmi". The study aimed to isolate arabinoxylan gum from leaves of *Neolitsea cassia* and evaluate the suitability of the isolated gum as a thickening agent.
Study Design: Complete randomized design.
Place and the Duration of the Study: Department of Food Science and Technology, Faculty of Livestock, Fisheries, & Nutrition, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), Sri Lanka between April 2917 and August 2017.
Methodology: Arabinoxylan was extracted from leaves of *Neolitsea cassia* and analysed for its proximate composition and evaluate functional, antioxidant properties and stabilizing properties.

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Results: The extractable arabinoxylan content was 1.02% from the dried basis. To determine the suitability of the isolated gum as a thickening agent, the functional properties of the extracted arabinoxylan were evaluated. Water holding capacity, oil holding capacity and the solubility of the isolated arabinoxylan were 288.82±0.67% and 166.67±1.79% and 80.250±1.025% respectively. Solution of the extract with 5% (w/v) gave 395.00±2.567cp viscosity. Isolated arabinoxylan was shown to exhibit antioxidant activity and suggesting it can enhance antioxidant capacity in the food matrix.

Conclusion: Arabinoxylan gum can be extracted from leaves of *Neolitsea cassia* and it posses many physicochemical, functional and antioxidant properties to be used as an additive in food preparation.

Keywords: Arabinoxylan; emulsion stability; viscosity; functional property; Neolitsea cassia leaves.

1. INTRODUCTION

Hydrocolloids such as arabinoxylan are a group of long-chain polymers which are included under the dietary fiber group. These hydrocolloids can be classified into main three groups which are natural gum produced in response to wounding and exudates or seaweed hydrocolloids [1]. Arabic, guar gum, arabinoxylan gum are some of the examples of natural gum. Hydrocolloid has functional properties including thickening, gelling, emulsifying, stabilization, and coating agent and many of them are used in the food industry because of their ability to modify the rheology of the food systems [1]. It mainly controls the flow behavior (viscosity) and mechanical solid property (texture) of the system. The modification of the viscosity and the texture property of the system it helps to modify the sensory property. Therefore arabinoxylan like hydrocolloids are used as food additives to perform specific purposes in various foods including sauces, salad dressings, soups, gravies and topping [2]. Among the gum used in the food industry, arabinoxylan is also plant extracted gum and it is classified under dietary fiber group which contains higher nutrition benefits. Structure of the arabinoxylan mainly influences the control of all the properties such as texture, viscosity, emulsion stability and flow behavior. Therefore, it is used as stabilizers in many food systems [2].

Neolitsea cassia, in Sinhala it is known as "Dawul Kurundu", is native to Sri Lanka and belongs to the Lauraceae family (Fig. 1). This plant is most popular among the villagers because gummy materials present in the leaves of this plant are used for a traditional sweet called "Asmi" preparation. Although leaves of *Neolitsea cassia* contain water-soluble arabinoxylan giving highly viscous solutions as described in De Silva et al. [3], no much research has been done to evaluate its physicochemical and functional properties to expand their usability as an ingredient in the food industry. However, there is several studies have been conducted to evaluate the physicochemical properties of water-extractable arabinoxylan gum from different types of cereals such as wheat [4,5], barley [6], rye [7] and bamboo shoots [8]. Therefore, in this research mainly focuses on Isolation, characterization, and evaluation of physicochemical and functional properties of arabinoxylan gum from leaves of *Neolitsea cassia* andevaluate its suitability as a thickening agent for food models such as sauce.

Fig. 1. *Neolitsea cassia* plants

2. MATERIALS AND METHODS

2.1 Materials

Leaves of *Neolitsea cassia* were collected from Nittambuwa area in Sri Lanka. The plant species was taxonomically identified by a botanist and the voucher specimen was kept in the herbarium of the Department of Food Science and Technology of Wayamba University of Sri Lanka. The collected leaves transported to the laboratory, cleaned and stored in polyethylene bags at -18°C in a freezer until analysis. Materials used for sauce formulations were purchased from Keels Super Market, Dankotuwa, Sri Lanka. Analytical grade chemicals were used for all analysis.

2.2 Isolation of Arabinoxylan Gum from Leaves of *Neolitsea cassia*

Leaves were washed properly and cut into small pieces and then were oven-dried at 50°C for 72 hours until constant weight. Dried leaves were ground and sieved through 450 mm sieve. Arabinoxylan gum was extracted using a method described by Gowda et al, [9] with some modifications according to the requirement. The leaf powder (20 g) was extracted in a Soxhlet apparatus, first with 1:2 benzene-methanol, and then with acetone, giving extractive-free powder. Ten grams leaf powder was allowed to swell overnight with 100mL water, stirred for 4 h, and the suspension centrifuged. Then the residue was three times extracted with water and then the combined aqueous solution was extracted with 4:1 chloroform-1-butanol, to remove proteins, and ethanol and the pale-brown precipitate formed were collected. To remove the lignin crude extract was dissolved in 50 mL water 15 mL containing glacial acetic acid and the mixture was heated to 50ºC and 1.5 g sodium chloride was added and stirred for a further 10 min. then the solution was cooled, dialyzed and lyophilized and the polysaccharide was collected. The leaf residue was three times treated with aqueous, 5% sodium hydroxide; the solution was partitioned with 4:l chloroform-methanol, and ethanol was added. The precipitate was collected and dissolved in 50 mL water, dialyzed and lyophilized. The polysaccharide was obtained as a white powder. The water extracted polysaccharide (300 mg) was dissolved in aqueous, 5% sodium hydroxide (80 mL), Fehling solution (20 mL) was added, and the mixture was kept for 30 min and the precipitate was separated. The supernatant liquor was cooled in ice, acidified with cold hydrochloric acid, and the polysaccharide (170 mg) precipitated with ethanol and this was designated as water-extractable arabinoxylan. The alkali-extracted polysaccharide was also fractionated as just described; to give Fehling solution-precipitable polysaccharide as designated alkali-extractable arabinoxylan.

2.3 Proximate Analyses of Gum Sample

Moisture, protein, and ash contents in extracted arabinoxylan samples were determined by using the methods described in AOAC 1999 [10]. Crude fiber contents were determined by the Weedy method using Fibertec™ M6 Fibre Analysis System as mentioned in AOAC [10]. Total carbohydrate content was determined by subtracting the sum of the values of crude protein, crude fat and ash content (% dry weight basis) of the sample from 100.

2.4 Total Sugar Content

Reducing sugar content was quantified by using the dinitrosalicylic acid assay (DNS assay) as described by Miller [11].

2.5 Determination of Equivalent Weight

The equivalent weight of the extracted arabinoxylan was determined according to the method described by Ranganna [12]. Briefly, about 0.5 g of gum sample was weighted into 250 ml conical flask and moistened with 5ml ethanol. 1.00 g of sodium chloride was added to sharpen the endpoint. Carbon dioxide-free distilled water 100.00 ml and 6 drops of phenol red were added. Then it was titrated with 0.1N sodium hydroxide until the color of the indicator changed. The equivalent weight was determined using the following equation.

> Equivalent weight = ((Weight of the sample (g) × 1000) / (Volume of alkali (ml) × Normality of the alkali))

2.6 Functional Properties of Isolated Gum Sample

2.6.1 Water Holding Capacity (WHC) and Oil Holding Capacity (OHC)

Water holding capacity and oil holding capacity were determined according to the method of Gannasin et al. [13] with some modifications. Briefly, 10 mL of distilled water and coconut oil were separately added to 250 mg of dry sample, stirred and left at room temperature for 1 h. After

centrifugation, the residue was weighed. The units of the WHC and the OHC were used as gram of water held per gram of sample and gram of oil held per gram of sample respectively.

2.6.2 Determination of emulsifying properties

The emulsion stability (ES) of the emulsion (diluted) was determined as turbidity as mentioned in Einhorn-Stoll and Kunzek [14] with some modifications.

T= 2.303AD/l,

Where T= turbidity in 1/cm, A= observed absorbance at 650 nm, D= dilution factor and l= path length of the cuvette in cm. The absorbance of the diluted emulsion was measured immediately in a 1 cm path length cuvette at a wavelength of 650 nm using a UV-Visible spectrometer to determine EA as turbidity. The bottles containing the emulsion were set on the bench at ambient temperature (22-24^{o}C) or in an oven at 45^{o}C without agitation for gravity separation. The emulsion breakage was observed daily by absorbance at 650nm, as loss of turbidity, to determine the ES. The ES study was done for 14 days (for the experiment conducted at 45^{o}C). A 10% sugar solution containing 0.1% sodium benzoate and 0.3% citric acid was used as a blank for the absorbance measurements.

2.6.3 Solubility of gum sample

The solubility of the isolated gum was determined by using the method described by Dakia et al. [15] with some modifications. Briefly, the gum sample was prepared at 0.1% w/w concentration on a DW basis at room temperature (30°C) for 0.5, 1, 2 and 3h under mechanical stirring. Other preparations were made at the same solid concentration (0.1% w/w) at 80°C for 5, 10, 30 and 60 min. Then the corresponding solution was taken and centrifuged at 6000g for 30 min at room temperature) to remove the insoluble material. The supernatant recovered and the final polymer concentrations were determined as total solid dried at 105°C for 24h in an oven (Model no: MEMMERT NLE 500).

2.7 Antioxidant Activity of Arabinoxylan Gum

2.7.1 Total phenolic content

Total phenolic content was determined by the Folin-Ciocalteau colorimetric method as described by Gunathilake [16] with some modifications by Gunathilake et al. [17] previously with some modification. Briefly, 0.5 mL of gum solution (1-10%w/v) was added into 2.5 mL of 1:10 diluted Folin-Ciocalteu reagent and 2mL of saturated sodium carbonate solution (about 75 g/L) was added to each of the gum samples. The absorbance of samples was measured at 760 nm after 2 hours. Gallic acid used as standards and the results were expressed as mg of gallic acid equivalents (mg GAE)/g of gum solution.

2.7.2 Total flavonoid content

Total flavonoids content of the isolated arabinoxylan gum was determined using the colorimetric assay described in Gunathilake et al. [18].

2.7.3 DPPH radical scavenging assay

DPPH radical scavenging effect of gum sample was determined by the method reported by Gunathilake et al. [17] with some modification. Briefly, a known concentration of gum dissolved in ethanol Extracts (100 µL) were dissolved in 3.9 mL freshly prepared ethanolic solution of DPPH (1 mM, 0.5 mL). Then the mixture was vortexed for 15 seconds and then left to stand at room temperature for 30 min in the dark. Then the absorbance was measured at 517 nm using a spectrophotometer (SP-3000, OPTIMA INC, Japan). The % inhibition of the radicals due to the antioxidant activity of the gum extracts was calculated using the following formula.

$$\% \text{ inhibition} = \{(A_{control} - A_{sample}) A_{control}\} \times 100$$

$A_{control}$ is the absorbance of the DPPH solution with nothing added (control).

2.7.4 Hydrogen peroxide scavenging assay

According to the Xiong et al. [19] method, H_2O_2 scavenging activity was determined. H_2O_2 (40 mM) solution was prepared in Na_2HPO_4 and NaH_2PO_4 buffer solution at pH 7.40, 0.2 M. A series of different concentration of gum samples were prepared (0.1 to 10 mg/ml) in distilled water and about 0.6 mL, 40 mM H_2O_2 solution was added to each sample and the absorbance was measure at 230nm after incubated with the dark place. The blank was prepared with phosphate buffer and without adding H_2O_2. The H_2O_2 scavenging % was calculated in comparison with the control.

2.7.5 Total antioxidant capacity

The total antioxidant assay was expressed using phosphomolybdenum assay was used as mentioned in Gunathilake et al. [20]. Molybdate reagent was prepared by adding 1 mL each of 0.6M Sulphuric acid, 28 mM of Sodium phosphate and 4 mM Ammonium molybdate. About 20 mL of distilled water was added and make up the volume to 50 mL by adding distilled water further. Then, 3 ml distilled water and 1mL of Molybdate reagent were added to the extracted sample and incubated at 95^{o}C for 90 min Absorbance was measured at 695nm.

2.8 Evaluate Suitability for Food Models as a Thickening Agent

To determine the suitability of isolated arabinoxylan as a stabilizer in a food system, tomato sauce with isolated arabinoxylan or xanthan gum was prepared, evaluated and compared. Four levels of stabilizers, 0.05%, 1%, 1.5%, 2% & 4% were used for the study. Viscosity and the water activity of the prepared tomato sauces were analyzed. Viscosity was measured using a capillary viscometer (Fungilab S.A viscometer and No.5 spindle and the 60rpm shear rate were used).

2.9 Statistical Analysis

All values were calculated as a mean with a standard deviation of three triplicates. Complete randomized design (CRD) was used and analysis of variance (ANOVA) and mean comparison was done by using the SAS system.

3. RESULTS AND DISCUSSION

3.1 Effect of Extraction Process on Arabinoxylan Yield from Leaves of *Neolitsea cassia*

Arabinoxylan is a type of hydrocolloid system which is used in the food industry as a stabilizing agent, thickening agent, emulsification agent and binding agent [21]. It is a natural substance that is present in specific plant groups. Arabinoxylan yield is mainly depending on the extraction process and Table 1 shows the extraction yield of arabinoxylan. In terms of extractability of arabinoxylan from leaves of *Neolitsea cassia*, total arabinoxylan extracted was 1.05 g arabinoxylan from 10 g of dried leaf powder and about 55.05% of them are water-extractable arabinoxylan. In wheat flour, typical total arabinoxylan content ranges from 1.4–2.5%, and 25–40% of the arabinoxylan is water-extractable [6, 22]. According to the literature presence of a high amount of hydroxyl group, arabinoxylan molecule can be bound by different components. In the water-extractable method, there were no specific chemicals used for the extraction process and therefore bound arabinoxylan not released from the plant matrix. In the extraction process, pre-treatment was done before the extraction process with organic solvents to remove lipo-soluble components such as waxes and pigments. Mild treatment with sodium chlorite resulted in the complete removal of lignin and partial removal of protein. According to the study results equivalent weight of arabinoxylan was calculated using a method described by Ranganna [12]. It gave 46631.57g/mol. Water-extractable arabinoxylan from Rye, a weighted average molecular weight of from 35 000 to 160 0000g/mol. Water extractable arabinoxylan from the bark of Avocado (*Persea americana*) had a 60000g/mol molecular weight [9]. Arabinoxylan is a plant extracted gum which also expressed some specific characteristics. There is no research conducted to evaluate the physicochemical and functional properties of arabinoxylan gum from *Neolitsea cassia* leaves until now. But there is so much research conducted to evaluate the physicochemical and functional properties of arabinoxylan from cereals.

3.2 Extraction Yield and the Proximate Composition of Arabinoxylan Gum

The proximate composition of arabinoxylan gum is presented in Table 1 and it shows higher fiber content and also a significant amount of protein. As protein is a polar molecule, it can bind polar components in the food system. For example, in the beverage industry, it is used as a flavor stabilizer [23]. However, based on previous studies by Dakia et al. [15], locust bean gum isolated showed higher protein and fat content about 7.4% and 1.5 respectively which are higher than those present in arabinoxylan isolated from *Neolitsea cassia* leaves. Generally, cereals arabinoxylan has high protein content for example, arabinoxylan isolated from hull-less barley flour contains about of 9.7-11.40% protein [6]. Isolated arabinoxylan from *Neolitsea cassia* leaves contains about 20.35±0.56 mg/g reducing sugars. De Silva et al. [3] also reported that arabinoxylan extracted from *Neolitsea cassia* leaves contains less sugar.

Table 1. Proximate composition of arabinoxylan gum from leaves of *Neolitsea cassia*

Property	Value
Alkali extracted Arabinoxylan	1.05g /10g dried leaf
Water extractable Arabinoxylan	0.58g/10g dried leaf
Moisture content (%)	4.56± 0.085
Ash content (%)	4.64± 0.182
Protein content (%)	2.47± 0.758
Fiber content (%)	5.94± 0.372
Fat content (%)	0.60± 0.01
Reducing sugars mg/g	20.35±0.564

All values are expressed as mean ± standard deviation of triplicate

3.3 Functional Properties of Arabinoxylan Gum

Table 2 is presenting some functional properties of isolated arabinoxylan gum from *Neolitsea cassia* leaves. These functional properties such as solubility, viscosity, and gelling capacity are closely related to their chemical structure, conformation, and molecular interaction. Results showed that isolated arabinoxylan showed higher water holding capacity, oil holding capacity, and the solubility. The water holding capacity of the gum sample was 288.82± 0.667% and it is mainly depending upon the carbohydrate composition, branching and molecular structure of the fiber present in isolated gum. According to Yadav et al. [24], arabinoxylan extracted from cereals expressed high WHC. It is a variation from 6.4 to 74.3g/g (water/fiber). According to Rosell et al. [25], arabinoxylan content is mainly affected by water holding capacity and dough rheology. Arabinoxylan can control its unique physiochemical properties to have a considerable effect on cereals based products, including bread-making, gluten-starch separation and refrigerated dough formation [25]. As well as arabinoxylan which is extracted from maize bran has a higher capacity of the oil in a water emulsion system. Due to that features arabinoxylan gum can be used in the food industry as a cloudy thickening agent for beverages [23]. The presence of oxidative ferulic acid cross-links as explained in De Silva [3] may increases the strength and permanence of this water-holding capacity and makes gels more elastic.

Table 2. Functional properties of arabinoxylan gum isolated from *Neolitsea cassia*

Property	Value
Water holding capacity (%)	288.82± 0.667
Oil holding capacity (%)	166.67 ±1.792
Solubility (%)	80.250±1.025
Viscosity (5% w/v) cp	395.00 ± 2.567

3.4 The Solubility of the Arabinoxylan Gum

An overview of the curves of solubility measurement in Fig. 2 shows that arabinoxylan gum isolated from *Neolitsea cassia* leaves shows it is partially, only about 30% (at 5ºC), cold-water-soluble and which is indicating that the extracted gum needs heat to reach its maximum solubility which is about 75% at 60ºC. Similar trends were also reported previously locust bean [15], cashew gum [26] and guar gum and fenugreek gum [27]. This difference in solubilization may be due to the fact that at high temperatures some molecules such as high molecular weight constituents are dissolved which are not at low temperature. In general, the solubility of isolated arabinoxylan gum from *Neolitsea cassia* does not exceed 80%, which may be related to some variables such as the size of the particles and impurities.

3.5 The Viscosity of the Arabinoxylan Gum

Viscosity is the resistance of a liquid to flow caused by its internal friction and shirring time and the shirring rate is the main factor effect for the viscosity of the gum solution [28]. The relative viscosity of *Neolitsea cassia* leaves arabinoxylan gum in comparison with commercial xanthan gum is shown in Fig. 3. Due to the change of viscosity with shearing time and the temperature, it shows non-Newtonian fluid behavior and according to Katzbauer [28], xanthan gum presented non-Newtonian and highly pseudoplastic nature. A similar trend also found in arabinoxylan isolated from *Neolitsea cassia* leaves though the relative viscosity is lower compared with xanthan gum**.** Generally, cereal arabinoxylan in 4% (w/v) gives higher viscosity and a significant degree of shear thinning, implying that even though they are high viscosity at higher shear rates, they lose much of their viscosity at higher shear rates [24]. However, arabinoxylan gum solution, 5% (w/v) exhibited a higher viscosity up to certain shear stress and beyond a certain level, increased

shear stress did not express higher viscosity. Viscosity is varied with the arabinoxylan content and at the concentration of 5% (w/v) it showed a 395.00 ± 2.567cp viscosity (Table 2). The presence of different sugars, as well as the branching of the constituents of arabinoxylan polymers, is affected for the functional properties of the gum and when a gum consists of higher branching molecules exhibited higher viscosity values and the viscosity is correlated to water holding capacity [23].

3.6 Emulsion Stability of Arabinoxylan Gum

Emulsion stability can be defined as the maintenance of a homogenous system. Fig. 4 describes the emulsion stability of the isolated gum solution at room (A) and 45ºC temperatures daily. ES can be evaluated by measuring the absorbance of the diluted emulsion from the clear droplet-droplet solution at the bottom and converting it into turbidity. If the higher turbidity, it showed a higher emulsion stability [2]. According to the results the initially it expressed higher turbidity indicating higher emulsion stability. According to Yadav et al. [2], it was suggested that the protein content may be partially or fully responsible for the emulsifying activity. For better understanding, it isessential to study the molecular characterization of these isolated arabinoxylans to make a clear interpretation of the molecular basis of the emulsifying property.

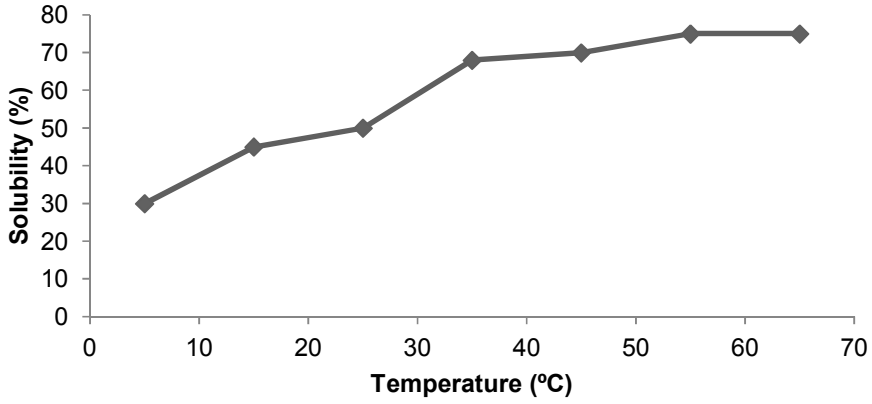

Fig. 2. The solubility of arabinoxylan gum isolated from *Neolitsea cassia* leaves at a different heating temperature

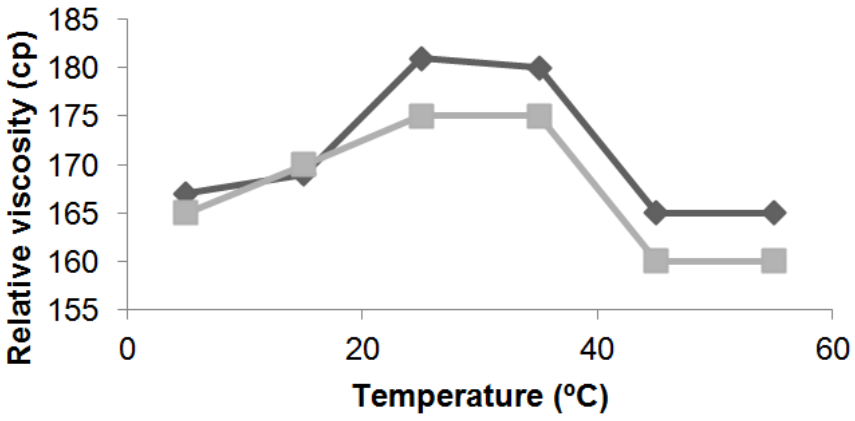

Fig. 3. The relative viscosity of *Neolitsea cassia* leaves arabinoxylan guMm(B) and commercially available xanthan gum (A) (5% w/v) solution at different temperatures

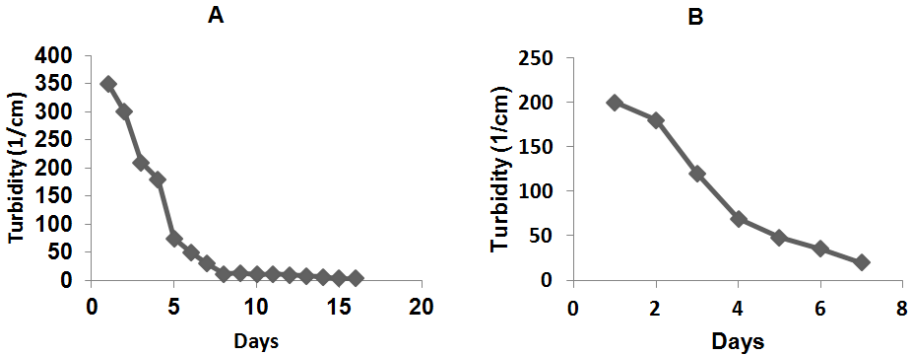

Fig. 4. Change of emulsion stability in terms of turbidity of gum solution at room temperature (A) and 45 ºC temperature (B) right after preparing a diluted emulsion daily basis

3.7 Antioxidant Property of Arabinoxylan Gum

The total phenolic contents of the arabinoxylan gum isolated from *Neolitsea cassia* leaves was estimated using the Folin-Ciocalteu method, which relied on the transfer of electrons from phenolic compounds to the Folin-Ciocalteu reagent in alkaline medium. The total phenolic content of isolated arabinoxylan was 54.67+1.65 mg gallic acid equivalent per gram (mg GAE/g) of gum powder. Deng et al. [29] have reported that the phenolic acid content of the corn fiber gum was 67.66±4.71 mg (GAE/g) and corn fiber gum is represented more than 80% of arabinoxylan.

Antioxidant activity of the gum sample is mainly depending on the structural components attached to the arabinoxylan gum and among many phenolic molecules, ferulic acids, uronic acids are sinapic acid is main phenolic acids which are responsible for the antioxidant capacity of the arabinoxylan [30,31]. DPPH radicals and hydrogen peroxide scavenging ability of the isolated arabinoxylan from *Neolitsea cassia* leaves are shown in Fig. 5. DPPH radical is one of the molecules that contain a proton-free radical with characteristic absorption and it is decreased significantly when exposing to the proton radical scavengers. This DPPH radical scavenging by various antioxidants is due to their hydrogen donating ability. In the DPPH scavenging experiment, the purple color of the reaction mixture was changed to yellow and its absorbance (517 nm) decreased in the presence of the antioxidant samples. This principle was utilized to antioxidant potent of the gum sample. The DPPH radical scavenging activity was 9.87± 0.4% at 1% (w/v) isolated arabinoxylan sample.

Hydrogen peroxide itself is not very reactive, but it can sometimes toxic to cell and H_2O_2 can cross cell membranes rapidly and once inside the cell, it can potentially react with Fe^{2+} or Cu^{2+} to form hydroxyl radicals [17]. The H_2O_2 scavenging activity of isolated gum samples (0.1-10mg/ml) is shown in Fig. 5. Higher H_2O_2 scavenging ability was observed at higher concentrations of arabinoxylan gum and the least scavenging activity was observed in 1 mg/mL. The IC_{50} of the isolated arabinoxylan gum was nearly 3 mg/mL. Based on the previous findings of other isolated arabinoxylan gum, hydroxyl radicals scavenging activity of the sulfated derivative of guar gum and xanthan oligosaccharides was reported to be 50% at 7.79 mg/ml, 2.5 mg/ml respectively [19]. Overall, these results suggesting that isolated arabinoxylan gum from *Neolitsea cassia* leaves may enhance antioxidant capacity in the food matrix and which is helping in preventing chronic diseases by mitigating the toxicity of free radicals. The most of the chronic diseases including cancer, diabetic and cardiovascular diseases are associated with oxidative stress.

3.8 Evaluation of Isolated Arabinoxylan Gum as a Thickening Agent for Food Models

The stabilization agent is the main preliminary factor that affects the texture of the sauce. Results revealed that there was no significant difference ($p< 0.05$) between 0.4% arabinoxylan incorporated tomato sauce with commercially available tomato sauce and 0.2% xanthan gum incorporated sauce (Fig. 6). The water activity of all sauces evaluated remained at 0.8 and was not significantly different among the sauce samples. This result indicating that isolated arabinoxylan from *Neolitsea cassia* leaves at a level of 0.4% gives the required textural properties to the product.

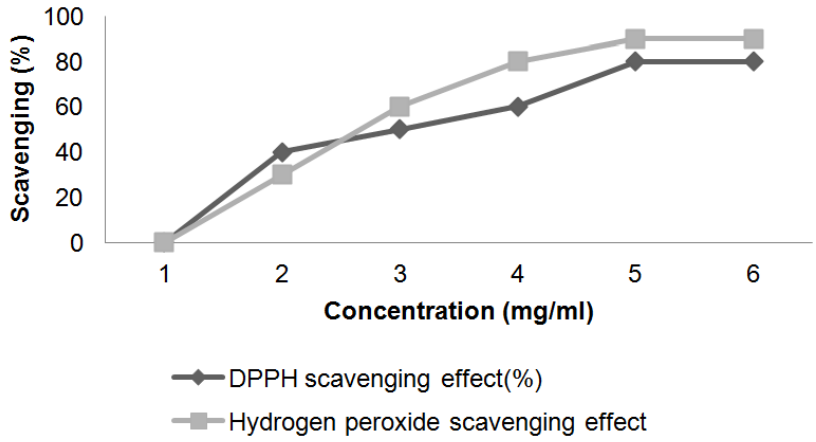

Fig. 5. DPPH radicals and Hydrogen peroxide scavenging percentages of isolated arabinoxylan from *Neolitsea cassia* leaves

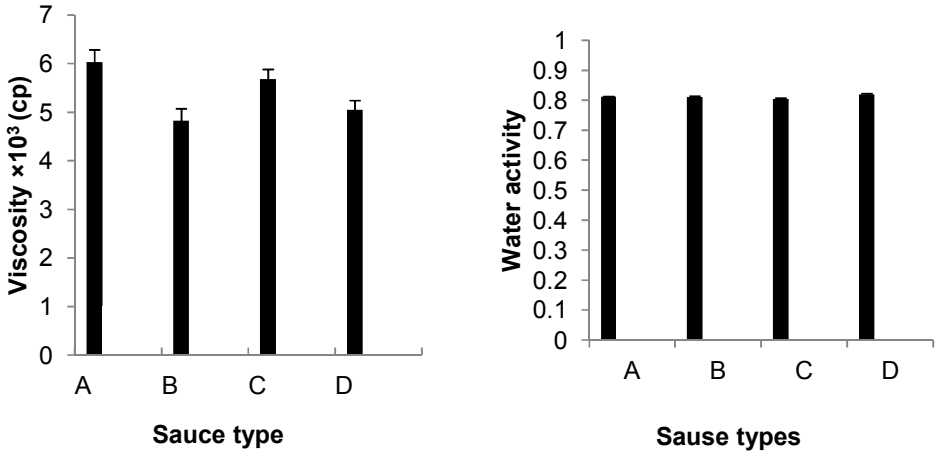

Fig. 6. Viscosity and water activity of commercially available tomato sauce (a), sauce incorporated with 0.2% isolated arabinoxylan (b), sauce incorporated with 0.4% isolated arabinoxylan and sauce incorporated with 0.2% xanthan gum

4. CONCLUSION

Neolitsea cassia leaves are an interesting raw material for the isolation of arabinoxylan. Isolated arabinoxylan gum showed higher water holding capacity, oil holding capacity, and solubility when compared with arabinoxylan isolated from other sources which are already used in the food industry. It shows viscosity modifying the ability of the food system without affecting other properties in the food system. Further, isolated arabinoxylan was shown to exhibit antioxidant activity by using DPPH radical, H_2O_2 antioxidant assays. This result may suggest that isolated arabinoxylan can enhance antioxidant capacity in the food matrix and may help in preventing chronic diseases by mitigating the toxicity of free radicals.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Milani J, Maleki G. Hydrocolloids in food industry. Food Industrial Processes–Methods and Equipment. 2012;2:2-37.

2. Yadav MP, Johnston DB, Hicks KB. Corn fiber gum: New structure/function relationships for this potential beverage flavor stabilizer, Food Hydrocolloids. 2019; 23(6):1488–1493.
DOI: 10.1016/j.foodhyd.2008.08.012
3. De Silva SSM, Kumar NS, Åman P. Structural studies of an arabinoxylan isolated from the leaves of Neolitsea cassia. Carbohydrate Research. 1986;152: 229-236.
4. Wang P, Hou C, Zhao X, Tian M, Gu Z, Yang R. Molecular characterization of water-extractable arabinoxylan from wheat bran and its effect on the heat-induced polymerization of gluten and steamed bread quality. Food Hydrocolloids. 2019; 87:570-581.
5. Pavlovich-Abril A, Rouzaud-Sández O, Carvajal-Millán E, Navarro RE, Robles-Sánchez RM, Barrón-Hoyos JM. Molecular characterization of water-extractable arabinoxylans isolated from wheat fine bran and their effect on dough viscosity. Lebensmittel-Wissenschaft und -Technologie- Food Science and Technology. 2016;74:484–492.
6. Trogh I, Courtin CM, Delcour JA. Isolation and characterization of water□extractable arabinoxylan from hullless barley flours. Cereal Chemistry. 2004;81(5):576-581.
7. Wang P, Tao H, Jin Z, Xu X. Impact of water-extractable arabinoxylan from rye bran on the frozen steamed bread dough quality. Food Chemistry. 2016;200:117–124.
8. Zelaya VM, Fernández PV, Vega AS, Mantese AI, Federico AA, Ciancia M. Glucuronoarabinoxylans as major cell walls polymers from young shoots of the woody bamboo *Phyllostachys aurea*. Carbohydrate Polymers. 2017;167:240-249.
9. Gowda DC, Sarathy C, Raju TS. Structural investigations on the mucilaginous polysaccharides isolated from bark of the avocado tree (*Persea americana* mill). Carbohydrate Research. 1988;177:117-125.
10. AOAC. Association of Official Analytical Chemists, Official Methods of Analysis. Washington DC; 1999.
11. Miller GL. Use of dinitrosalicylic acid reagent for determination of reducing sugar. Analytical Chemistry. 1959;31(3): 426-428.
12. Ranganna S. In Handbook of analysis and quality control for fruits and vegetable products. Tata Mc Graw-Hill publishing company Ltd, New Delhi. 2000;33-65.
13. Gannasin SP, Ramakrishnan Y, Adzahan NM, Muhammad K. Functional and preliminary characterization of hydrocolloid from tamarillo (*Solanum betaceum* Cav.) puree. Molecules. 2012;*17*(6):6869-6885.
14. EinhornStoll U, Weiss M, Kunzek H. Influence of the emulsion components and preparation method on the laboratoryscale preparation of o/w emulsions containing different types of dispersed phases and/or emulsifiers. Food/Nahrung. 2002;46(4): 294-301.
15. Dakia PA, Blecker C, Robert C, Wathelet B, Paquot M. Composition and physicochemical properties of locust bean gum extracted from whole seeds by acid or water dehulling pre-treatment. Food Hydrocolloids. 2008;22(5):807-818.
16. Gunathilake KDPP. A fruit-based functional beverage designed to reduce the risk of cardiovascular disease. M.Sc. Thesis, Dalhousie University, Canada; 2012.
17. Gunathilake KDPP, Ranaweera KKDS, Rupasinghe HPV. Analysis of rutin, β-carotene, and lutein content and evaluation of antioxidant activities of six edible leaves on free radicals and reactive oxygen species. Journal of Food Biochemistry. 2018;42(5):e12579.
18. Gunathilake KDPP, Ranaweera KKDS, Rupasinghe HP. *In vitro* Anti-inflammatory properties of selected Green Leafy vegetables. Biomedicines. 2018;6(4):107.
19. Xiong X, Li M, Xie J, Jin Q, Xue B, Sun T. Antioxidant activity of xanthan oligosaccharides prepared by different degradation methods. Carbohydrate Polymers. 2013;*92*(2):1166-1171.
20. Gunathilake KDPP, Ranaweera KKDS, Rupasinghe HPV. Effect of different cooking methods on polyphenols, carotenoids and antioxidant activities of selected edible leaves. Antioxidants. 2018; 7(9):117.
21. Han JY, Schwarz PB. Arabinoxylan composition in barley, malt and beer. Journal of the American Society of Brewing Chemists. 1996;54(4):216-220.
22. Cleemput G, Roels SP, Van Oort M, Grobet PJ, Delcour JA. Heterogeneity in the structure of water-soluble arabinoxylans in European wheat flours of

variable bread-making quality. Cereal Chem. 1993;70:324-329.

23. Yadav MP, et al. Corn fiber gum: A potential gum arabic replacer for beverage flavor emulsification, Food Hydrocolloids. 2007;21(7):1022–1030.
DOI: 10.1016/j.foodhyd.2006.07.009
24. Yadav MP, et al. Isolation, characterization and the functional properties of cellulosic arabinoxylan fiber isolated from agricultural processing by-products, agricultural residues and energy crops. Food Hydrocolloids. 2017;63:545–551.
DOI: 10.1016/j.foodhyd.2016.09.022
25. Rosell CM, Rojas JA, Benedito de Barber C. Influence of hydrocolloids on dough rheology and bread quality. Food Hydrocolloids. 2001;15(1):75–81.
DOI: 10.1016/S0268-005X(00)00054-0
26. Zakaria MB, Rahman ZA. Rheological properties of cashew gum. Carbohydrate Polymers. 1996;29(1):25-27.
27. Maier H, Anderson M, Karl C, Magnuson K, Whistler RL. Guar, locust bean, tara and fenugreek gums. In RL Whistler, JN BeMiller (Eds.), Industrial gums, polysaccharides and their derivates. San Diego: Academic Press. 1993; 205–215.
28. Katzbauer B. Properties and applications of xanthan gum, Polymer Degradation and Stability. 1998;59(1–3):81–84.
DOI: 10.1016/S0141-3910(97)00180-8
29. Deng GF, et al. Determination of antioxidant property and their lipophilic and hydrophilic phenolic contents in cereal grains. Journal of Functional Foods. 2012; 4(4):906–914.
DOI: 10.1016/j.jff.2012.06.008
30. Malunga LN, Beta T. Antioxidant capacity of water extractable arabinoxylan from commercial barley, wheat and wheat fractions. Cereal Chemistry. 2015;92(1): 29-36.
31. Samuelsen AB, et al. Immunomodulatory activity of dietary fiber: Arabinoxylan and mixed-linked beta-glucan isolated from barley show modest activities *in vitro*, International Journal of Molecular Sciences. 2011;12(1):570–587.
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