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THEME

Acacia arabica, a good ingredient in a dietary cake

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Summary

Chapitre III. Results and discussion

DEDICATION

This study is wholeheartedly dedicated to my beloved parents, who have been our sourceof inspiration and gave us strength when i thought of giving up, who continually provide theirmoral, spiritual, emotional, and financial support. Who have always believed in me and supported me in all my endeavors.

To my little siblings , who shared their encouragement and support to finish this study.

And lastly, i dedicated this book to the Almighty God, thank you for the guidance,strength, power of mind, protection and skills and for giving us a healthy life. All of these, weoffer to you

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Abstract

The study focuses on *Acacia arabica*, a plant harvested in different regions of Ouargla wilaya and Illizi wilaya in November and December 2023. It's naturally found in Africa and parts of Asia. It delves into the botanical description, origin, distribution, and uses of *Acacia arabica*, highlighting its importance in various fields. *Acacia arabica* is used for various purposes like fodder, fuelwood, timber, gum, and medicine. The roots, leaves, gum, stem bark, seeds, and pods contain various bioactive compounds and are used to treat different ailments.

The research also explores the nutritional and pharmaceutical properties of *Acacia arabica*, emphasizing its value in dietetic preparations. Additionally, the study investigates the physicochemical properties and sensory attributes of *Acacia arabica* seeds and their incorporation into biscuits, The results showed that the seeds had moisture content of 5.88%. lower than the pods 35.71%. seed powder pH is 4.94 which falls into the acidic range, titratable acidity value of 32.16, sugar content 3.3 mg/ml. Seeds ash content 5.03%.

Keywords :

Acacia arabica, biscuits, Diet, Nutritional properties, Pharmaceutical, Physico-chemical properties.

Résumé :

L'étude porte sur l'Acacia arabica, plante récoltée dans différentes régions de la wilaya de Ouargla et de la wilaya d'Illizi en novembre et décembre 2023. Cette plante se trouve naturellement en Afrique et dans certaines parties de l'Asie. Il s'agit d'une description botanique, de l'origine, de la distribution et de l'utilisation de l'Acacia arabica, en soulignant son importance dans différents domaines. L'Acacia arabica est utilisé à diverses fins, comme le fourrage, le bois de chauffage, le bois d'œuvre, la gomme et la médecine. Les racines, les feuilles, la gomme, l'écorce des tiges, les graines et les gousses contiennent divers composés bioactifs et sont utilisés pour traiter différentes affections.

La recherche explore également les propriétés nutritionnelles et pharmaceutiques de l'Acacia arabica, en mettant l'accent sur sa valeur dans les préparations diététiques. Les résultats montrent que les graines ont un taux d'humidité de 5,88%, inférieur à celui des gousses (35,71%). Le pH de la poudre de graines est de 4,94, ce qui correspond à un taux d'acidité, l'acidité titrable est de 32,16, la teneur en sucre est de 3,3 mg/ml. La teneur en cendres des graines est de 5,03 %.

Mots clés :

Acacia arabica, biscuits, Régime alimentaire, Propriétés nutritionnelles, Pharmaceutique, Propriétés physico-chimiques.

الملخص

تتناول الدراسة نبات الأكاسيا العربية، الذي تم جمعه من مناطق مختلفة في ولاية ورقلة وولاية إليزي في شهري نوفمبر وديسمبر .2023 ينمو بشكل طبيعي في أفريقيا وأجزاء من آسيا .تتناول الدراسة الوصف النباتي، والأصل، والتوزيع، واستخدامات الأكاسيا العربية، مع تسليط الضوء على أهميته في مجالات متعددة .تُستخدم الأكاسيا العربية لأغراض متنوعة مثل العلف، ووقود الأخشاب، والخشب، والصمغ، والطب .تحتوي الجذور، والأوراق، والصمغ، ولحاء الساق، والبذور، والقرون على مجموعة متنوعة من المركبات النشطة بيولوجيًا وتستخدم لعلاج مختلف الأمراض.

تستكشف الأبحاث أيضًا الخصائص الغذائية والصيدلانية للأكاسيا العربية، مع التأكيد على قيمتها في التحضيرات الغذائية . بالإضافة إلى ذلك، تحقق الدراسة في الخصائص الفيزيائية الكيميائية والخصائص الحسية لبذور الأكاسيا العربية وإدماجها في البسكويت .أظهرت النتائج أن محتوى الرطوبة للبذور هو5.88% ، وهو أقل من محتوى الرطوبة في القرون الذي يبلغ .35.71%يبلغ الرقم الهيدروجيني لمطحون البذور4.94 ، مما يقع في النطاق الحمضي، وقيمة الحموضة القابلة للتعيين 32.16، ومحتوى السكر 3.3 ملغ .ml/نسبة الرماد في البذور.5.03%

الكلمات المفتاحية : الأكاسيا العربية، البسكويت، النظام الغذائي، الخصائص الغذائية، الخصائص الصيدلانية، الخصائص الفيزيائية الكيميائية.

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Introduction

The growing demand for healthier food choices has fueled an increased interest in the utilization of natural, nutrient-rich substances that can be incorporated into everyday snacks and baked goods, offering consumers more wholesome alternatives to conventional products. The bibliometric analysis also found that while research on healthy eating has grown rapidly over the past two decades, key challenges remain in implementing healthy eating practices globally due to the complex interplay of human, socioeconomic, environmental and political factors. **(Fang *et al.,* 2023)** One such underexplored ingredient is *Acacia Arabica*, a leguminous tree native to parts of Africa and Asia, known for its nutritional and functional properties.

For hundred years it's has been used in traditional medicine, *Acacia Arabica*, also commonly referred to as babul or gum Arabic tree, is a rich source of dietary fiber, protein and various bioactive compounds like Tannin which is an active Chemical responsible for its anti-diabetic activity that have been associated with potential health benefits **(Kumar *et al.,* 2014).** For instance, its own extract has demonstrated significant antidiabetic effects in high fat-fed diet-induced obese Type 2 diabetic rats, enhancing insulin secretion and glucose uptake**(Ansari *et al.,* 2023)** , and inhibiting starch digestion and glucose diffusion and other phytoconstituents like alkaloids, polyphenolic compounds, and flavonoids all of them has a several health benefits that's has been proven in several studies.

That's how the incorporation of *Acacia Arabica* powder into baked goods like biscuits may provide an opportunity to develop a low-calorie, nutrient-dense alternative to traditional biscuits.

This study aims to investigate the feasibility of incorporating *Acacia Arabica* into biscuit formulations. the chemical composition and functional properties of Acacia Arabic, sensory analysis attributes of the biscuits as well as its potential health benefits.

Chapter I
Literature Review

I. Literature Review

I.1 General information and *Acacia arabica* nomenclature

I.1.2. Classification of *Acacia arabica*

Table 01: Taxonomical Classification of *Acacia arabica* **(Alam *et al*., 2018)**

Region	Plante
Embranchement	Spermatophytes
Sub-branch	Angiospermes
Class	Dicotyledon
Order	Fabales
family	The Fabaceae or Leguminosae
Subfamily	Mimosoideae
Genre	*Acacia*
Species	*arabica*

I.1.3. Geographical distribution of *Acacia arabica*

This Acacia is found throughout East Africa, as far as India. Introduced and naturalized in Mauritius and Rodrigues, in the north of Australia. And in Oceania.

It is naturally widespread in the drier areas of Africa, from Senegal to Egypt and southwards to South Africa (Natal) and through the Middle East to Asia as far eastwards as India and Bangladesh. **Houerou (1988)** collated information on the distribution of the various subspecies and reports depletion of native *A. nilotica* forests in Senegal, Niger and along the River Nile due to over-exploitation and man-made changes to the water table and flooding regimes. In Pakistan, some areas of riparian A. nilotica forests are being invaded by the introduced Prosopis juliflora

(IUCN, 2000). Currently, *A. nilotica* can be found naturalized and cultivated in Asia, Australia and the Caribbean **(ILDIS, 2015; PIER, 2015; USDA-ARS, 2015).**

- In some of its native range countries, *A. nilotica* appears to demonstrate invasive behaviour **(Holm *et al.*, 1979; Carter, 1998);** however, these records are likely to refer to introduced subspecies, such as A. nilotica subsp. Indica in East Africa.**(Figure 1).**

Acacia nilotica has been widely introduced and cultivated, including in parts of the Indian subcontinent and Pakistan (where it is not native), in the Caribbean, Australia, Cyprus, Tanzania (Zanzibar), Cape Verde, Iraq, Indonesia (Java, Lesser Sunda Islands), Vietnam, Nepal and Iran.**(Figure 2).**

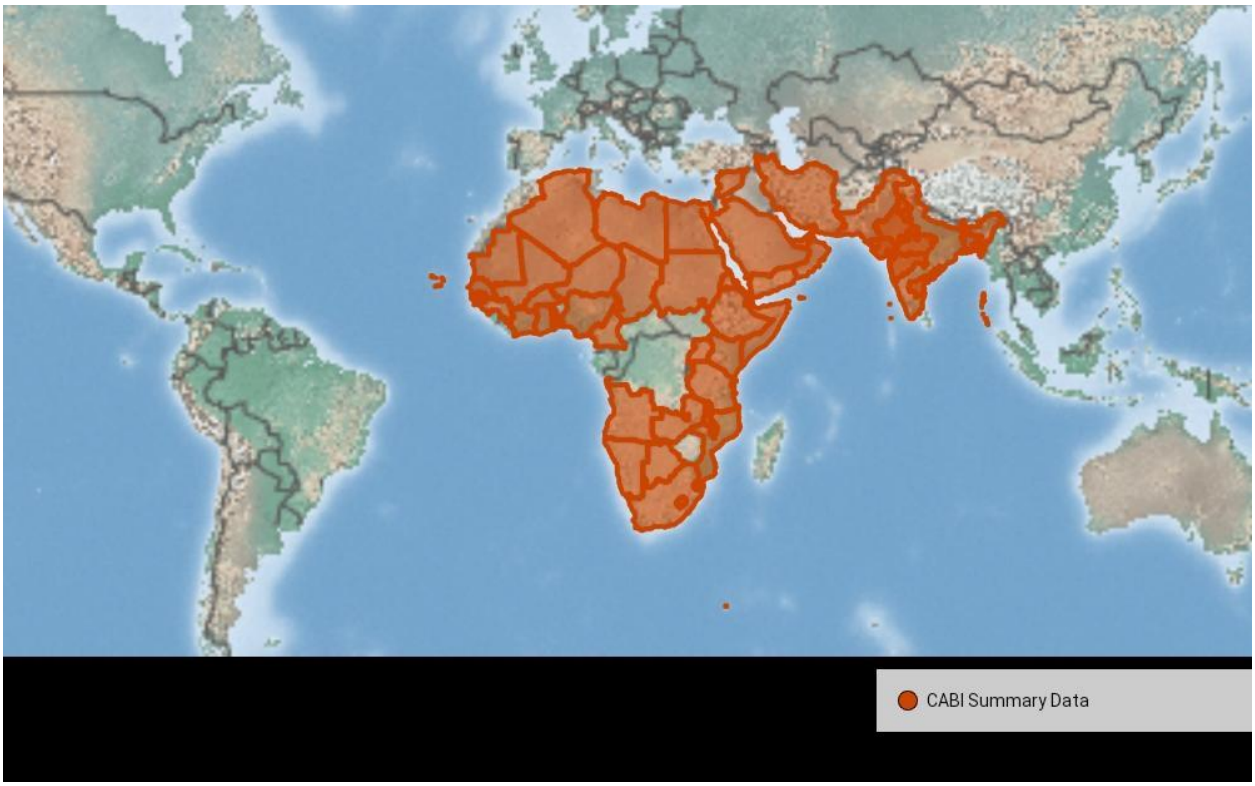

Figure 1: countries where *Acacia Arabica* is Native **(CABI International, 2022).**

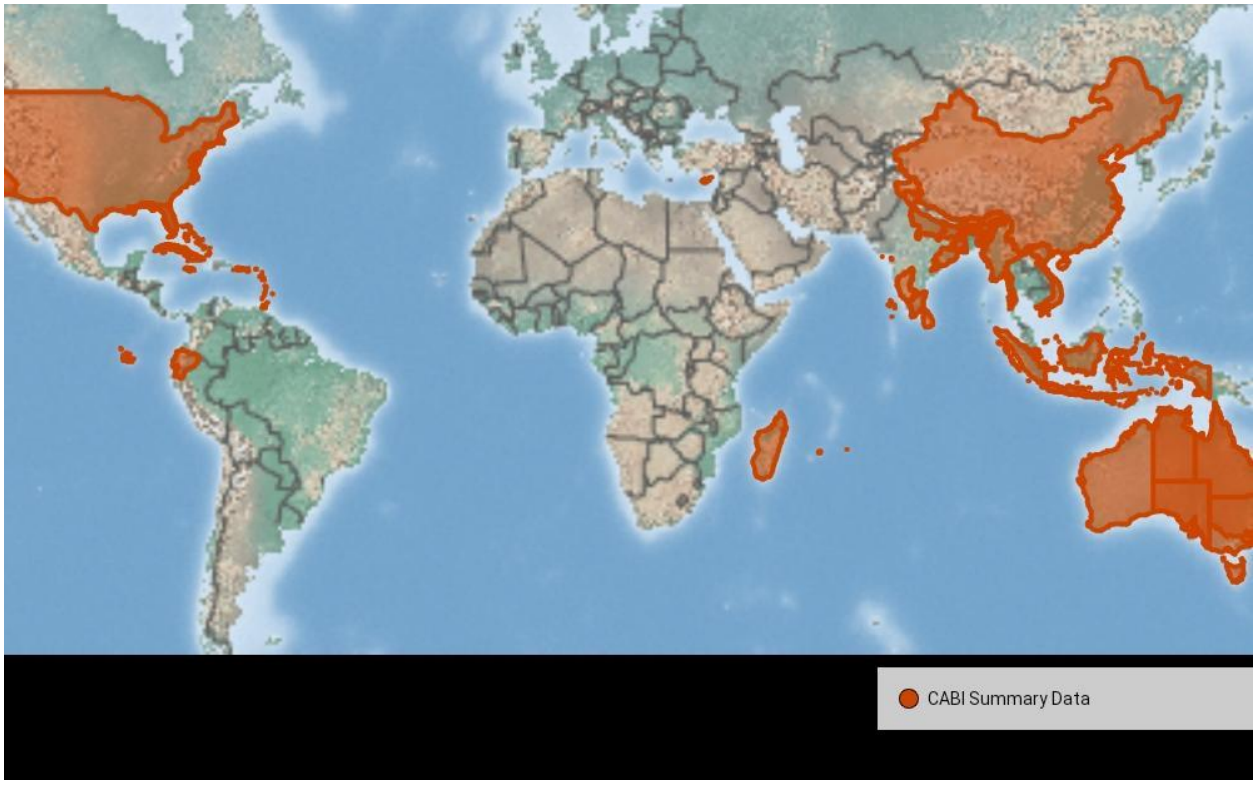

Figure 2: countries where *Acacia Arabica* is introduced **(CABI International, 2022).**

In Algeria, Acacia species make up what Maire called in 1940 the spiny desert savannah. **(Figure 3)** *Acacia arabica* is found in the large wadis, oases, Hoggar, Tassili n'Ajjer and the central Sahara central Sahara **(Quezel et Santa, 1962).**

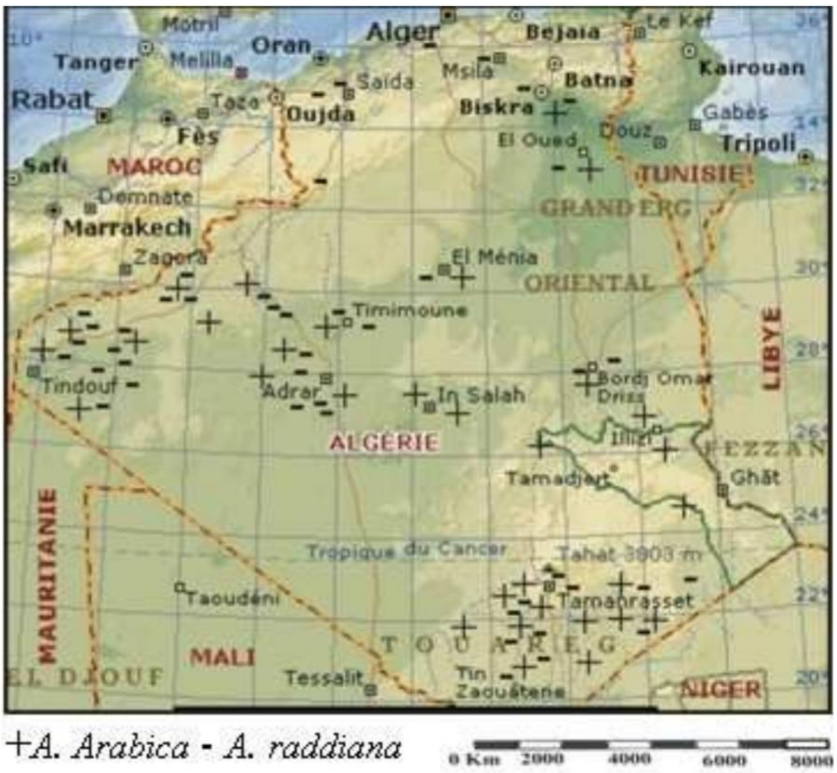

Figure 3 : Geographical distribution of *Acacia arabica* in Algeria.

(Tissouras, 2004).

I.1.4. Morphological description

This perennial shrub or tree can grow as tall as 20 m, ranging from 2.5 m. Branches with dark brown to black stems that are spread widely. Branchlets feature thick or thin hairs, lenticels, and a purple-brown color **(Bessong and Obi, 2006).**Fissured, intensely reddish-brown, and thin bark. Three to twelve pairs of light grey, straight, and slender thorns can be found on young trees **(El Tahir *et al.,* 1999).** Unlike mature trees, which frequently contain thorns, young trees typically do not. Bipinnate leaves are 2–11 (or even 17 pairs) long, with 1.5–3.0 petioles and stipules glands, additional cells between all pinnae or only the tallest ones, and a length of 30–40 mm. Each pinnae has 10–30 pairs of leaflets that are 2.0–8 mm long **(Hussein *et al.,* 2000).** The leafy and leafless branchlets' nodes grew peduncles. 1.0–1.6 cm in diameter, with multiple golden

yellow blooms on globulus heads. Young pods have a pedicel that is 4.5–13.5 cm long and 0.5–1.2 cm wide, with the gaps between the seeds seeming like a string of pearls. They are preadult, squishy, inert things before they mature to become hard and black. The areole is 4.0–5.5 mm in breadth and 6–7 mm length **(Rahaman, 2010).** The compressed, smooth, subcircular seeds are subcircular in shape and have a dark blackish-brown hue. Between 5000 and 16,000 seeds are included in every kilogram. The subsp. Nilotica's pods and twigs are glabrous, or closely so, but the subspecies kraussiana's have tightly and white-grey hairy pods. Pods of Subspecies adstringens are either completely unconstrained or barely constrained at all. Very little to no constriction is seen in Adstringens pods **(Bhatnagar *et al.,* 1973).**

I.2. *Acacia arabica* products

I.2.1. Phytochemical constituents

Acacia Arabica is known for its rich composition of phytochemical constituents. As it is a source of various types of phytoconstituents like Tannins, alkaloids, polyphenolic compounds, and flavonoids. Tannins are mostly found in the stem bark of *Acacia Arabica*, where their quantity ranges from 12 to 20 % The phytoconstituents, Methyl gallate is antimicrobial. **(Singh *et al.,* 2009).** tannins are also in the leafs **(Dogara *et al.,* 2023).**

Calcium, magnesium, and potassium salts of high molecular weight polysaccharides.Three fractions are produced by gum hydrolysis: arabinogalactan (81–84 %) arabinogalactan protein (8–10 %), and glycoprotein (<2 %). Arabinose, galactose, rhamnose, and glucuronic acids are the gum's primary carbohydrates**(Yaseen *et al.,* 2015).**

I.2.2 Nutritional and pharmaceutical properties of *Acacia arabica*

I.2.2.1 Nutritional properties

Leaves contain 2.2–2.6% N (Nitrogen), 16.9–20.0% NDF (Neutral Detergent Fiber), 13.3–14.1% ADF (Acid Detergent Fiber), 7.2–8.7 MJ/kg energy, 10–21% crude fiber and 6–9% condensed tannins.

Pod and seed contain 1.6–2.2% N(Nitrogen), 10 MJ/kg energy, 12–18% crude fibre and 4–7% condensed tannins.

Pods alone contain 2% N, 25% NDF, 17% ADF .In digestibility trials conducted in Zimbabwe, of several species browse species tested, intake of A. Nilotic was the lowest Nutritional value of the refined seed oils is done by rat bioassay and using peanut oil as control.The animals fed on 10 % seed oil diet showed poor growth performance and low feed efficiency ratio. The digestibility of the seed oil was 90 % as compared to 94 % for peanut oil. The seed oil in the diet of rats for 4 weeks did not produce any abnormal serum lipids or histopathological findings. The seed oil was apparently non toxic. The deoiled seed cake contains 21.9% protein and balanced amino acids but also contained antinutritional factors, tannins (4.2%) and saponins (2.4 %). The nutrient and amino acids composition of the detoxified seed meal (PAM) was almost similar to that of unprocessed seed meal except for antinutritional factors. PAM was nutritionally evaluated using rat bioassay produce in a comparative study with cesain as standard. Nutritional indices, biochemical parameters and histopathology findings indicated the possibility of using PAM as supplementary feed for livestock animals**(Maity and Mandal, 1990; Maity and Mandal, 1989)**

I.2.2.2Pharmaceutical and clinical properties

The pharmaceutical or clinical properties of *Acacia arabica* primarily revolve around its bioactive compounds.

Table 2. Some common medicinal uses of different parts of *A. nilotica*

Part used	**Uses**
Root	The roots are used against cancers and/or tumors (of ear, eye, or testicles), tuberculosis and indurations of liver and spleen**.(Kalaivani and Mathew, 2010)**
Leaf	Chemoprventive, anitmutagenic, anti bacterial, anticancer, astringent, anti microbial activity Tender leaves are used to treat diarrhea, Aphrodisiac dressing of ulcers, anti-inflammatory and Alzheimer's diseases **(Kalaivani and Mathew, 2010, Shittu, 2010: Kalaivani *et al.,* 2010)**
Gum	Astringent, emollient, liver tonic, antipyretic and antiasthmatic.**(Baravkar *et al.*, 2008)**
Stem bark	Anti bacterial, antioxidant, anti-mutagenic, cytotoxic bark is used as astringent. Acrid cooling, styptic, emollient, anthelmintic, aphrodisiac, diuretic, expectorant emetic, nutritive, in hemorrhage, wound ulcers, leprosy, leucoderma, small pox, skin diseases,

	bilicusness, burning sensation, toothache, leucoderma, dysentery and seminal weakness. The trunk bark is used for cold, bronchitis diarrhoea, dysentery, biliousness, bleeding piles and leucoderma**(Kaur *et al.,* 2005; Singh *et al.,* 2008; Singh *et al*., 2009; Del, 2009; Agrawal *et al.,* 2010; Kalaivani and Mathew, 2010)**
Seeds	Spasmogenic activity and antiplasmodial activity.**(El-Tahir *et al.,* 1999. Amos *et al.,* 1999)**
Pods	Anti hypertensive and antispasmodic, anti-dianhoerial, astringent, anti-fertility and against HIV-1 PR. Inhibited HIV-1 induced cythopathogenicity,antiplatelet aggregatory activity and anti oxidant**(Shah *et al.,* 1997; Gilani *et al.,* 1999; Asres *et al.,* 2005; Singh *et al.,* 2009)**

I.3. Main products made from *Acacia arabica*

Acacia nilotica is popular as an agroforestry tree, either sown in lines 5 m apart in agricultural fields, or on field crop boundaries. As a fodder tree, it is utilized in many different silvopastoral systems and its sweet-smelling pods are particularly sought out by animals. It is extensively used in land rehabilitation, being planted on saline and alkaline soils. It will also grow when irrigated with tannery effluent, or saline water and effectively colonizes waste heaps from coal mines. The tree is popular as a shelterbelt and there is interest in A. nilotica subsp. Cupressiformis as a windbreak surrounding fields because its narrow crown form produces less shade than other taxa. It is also a popular ornamental tree and is frequently planted in India as an avenue tree.

Since the time of the Pharaohs, large timber trees have been exploited from the riverine forests of the Nile in Sudan and Egypt. At present, forests in the Sudan are managed on a 20- to 30-year rotation, producing termite-resistant timber especially suitable for railway sleepers. In India and Pakistan, the riverine plantations are managed on 15- to 20-year rotations for fuelwood and timber such as mine props. The strong and durable wood is nearly twice as hard as teak and is very shock resistant. It is used in construction in tool handles and carts. Wood properties are reviewed by **Rao and Purkayastha (1972), Goldsmith and Carter (1981), Tewari and Rajput (1987) and Troup and Joshi (1983).**

The pods and leaves have high levels of crude (12.4%) and digestible protein (8%) and energy (7.2 MJ) and are rich in minerals **(Houerou, 1980).** Pods are used as a supplement to poultry rations in India. Dried pods are relished and particularly sought out by animals grazing on rangelands as the pods mature towards the end of the dry season. In India, branches are commonly lopped for fodder. Pods are best fed as a supplement.

A by-product from felling is the bark, which has high levels of tannin (12-20%) used for tanning leathers in India and the pods of *A. nilotica* subsp. Nilotica have been used for over 6000 years in Egypt for tanning. *A. nilotica* subsp. Adstringens is used both for tanning and as a dye in Nigeria.

The gum of *A. nilotica* was originally called gum arabic and has been collected from the Nile forests since the time of the Pharaohs, for use in paints and medicines. It has some properties similar to those of true gum arabic (from Acacia senegal) and is frequently used in calico printing, dyeing, sizing material for silk and cotton and in paper manufacture in India. In Mumbai, India, it is marketed as Amravati gum**.**

The tannin content contributes to the many medicinal uses of *A. nilotica*, acting as a powerful astringent. It has also been found to be a powerful molluscicide and algicide and the fruits, when added to ponds in Sudan, killed snail species which carry schistosomiasis, without affecting fish **(Ayoub, 1982).** The tree is a good host plant for growing lac (shellac) in Sind, Pakistan. An extract of the root is a potential inhibitor of Tobacco mosaic virus. In eastern Java, sprouted seeds are eaten as vegetables and well-roasted seeds are mixed with coffee **(Lemmens and Wulijarni-Soetjipto, 1991).** There are many other reported uses **(Fagg and Greaves, 1990).**

I.4. Importance of Dietetic Preparations

Nutrition is a complicated science that continues to change with new data, analysis, biochemical understanding, and dedication of resources.

Dietetic preparations are essential for maintaining good health and preventing various diseases.

The dietetic foods for medical use and disease prevention should satisfy the physiological needs of the human body in nutrients and energy intake accounting for the character, the physiological-biochemical nature of nosologies, and the pathogenesis of diseases among population groups, and disease risk factors. **(Tutelyan *et al.,* 2014)**

Dietetic foods are foods designated for carbohydrate, lipid, protein, vitamin, and other metabolism correction with modified content and/or ratios of certain substances compared to their natural content and/or with added substances or ingredients (absent in the original products). **(Tutelyan et al., 2019)**

Chapter II

Materials and Methods

□. Materials and Methods :

II.1 Plant material

II.1.1. Origin and preparation

The *Acacia arabica* plant was harvested in different regions of Ouargla wilaya and Illizi wilaya in November and December 2023 **(Figure 4)**. The pods of *Acacia arabica* are straight, nuty and gray-brown. **(Figure 5).** The seeds are tiny, oblong, brownish black, Non-endospermic and has a smoth texture. **(Figure 6)**

Figure 4: Geographical location of the plant: *Acacia arabica.*

Figure 5 : The Pods of *Acacia Arabic*

Figure 6 : *Acacia arabic* Seeds

Preparation:

The preparation of the *A. Arabica* plant material for analysis and the preparation of the biscuits involved a systematic process to ensure that the sample was clean and suitable for future use.

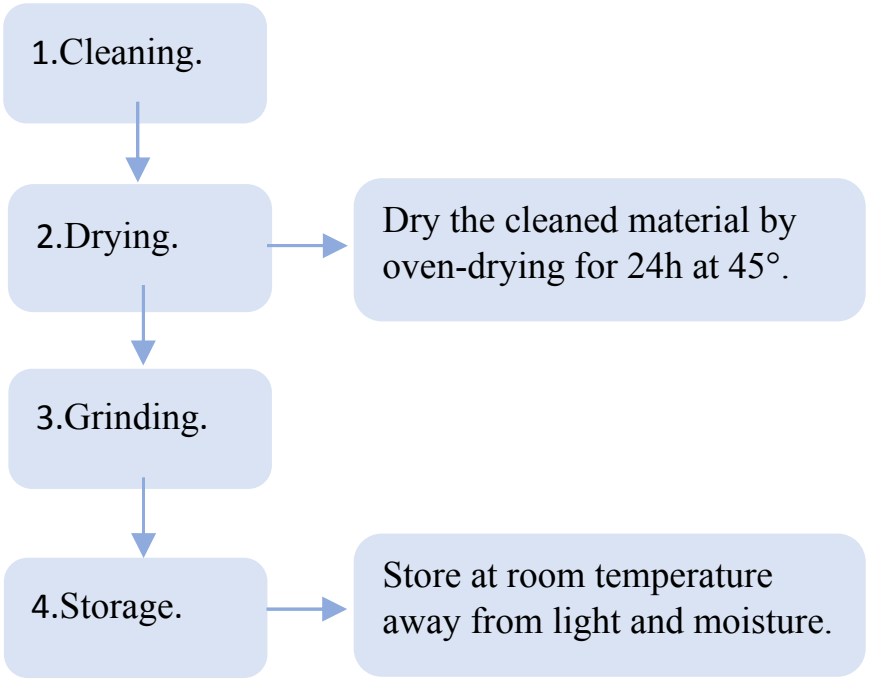

Figure 7: Procedural Diagram for *A. Arabica* Preparation

II.2. Physico-chemical analyses of *Acacia arabica*

II.2.1. Determination of moisture content

Moisture content rate is the percentage loss of water mass experienced by a sample under the conditions described by **AFNOR technique (1988).** The sample of Seeds or pods of *Acacia arabica* undergoes desiccation at a temperature of 105°C in an oven until a nearly constant mass is achieved. There are 3 repetitions, with each repetition representing a new weight g. Every 30 minutes, the weight is determined until it stabilizes. The average water content is expressed as a percentage using the following formula:

WC% is the percentage of Moisture content

w is the wet fresh weight of the sample in grams

d is the dry weight of the sample in grams

$$WC\% = (w - d) * 100$$

.2.2 Determination Ash content

It involves the incineration of a test portion until complete combustion of organic materials followed by weighing the residue obtained.**(AFNOR, 1977)**

Weigh 3g of *acacia arabica* powder for each sample (3 simples) into capsules and place the capsules in a muffle furnace at 500°C for 3 hours, then remove the capsules and cool in a desiccator before weighing.

- Expression of results:

The ash content, as a mass fraction relative to the dry matter (DM), expressed in percentage, is given by the following formula:

$$Ash\ \% = 100 - MO\%$$

$$Mo\% = \frac{M1 - M2}{p}$$

.2.3 Determination PH levels :

The pH corresponds to the concentration of H3O+ ions in the solution. If the pH is greater than 7, the solution is basic; if the pH is equal to 7, the solution is neutral; and if the pH is less than 7, the solution is acidic

Weigh 1g of the sample *Acacia Arabica* powder, add 10ml of distilled water, then agitate the mixture for 5 minutes. The pH is measured using a pH meter.

- Expression of results
- The pH value is obtained by three readings of the pH meter. **(AOAC, 2000)**

.2.4 Titratable acidity

Titratable acidity is the measurement of the amount of organic acid present in a sample. The potential acidity is titrated by sodium hydroxide in the presence of phenolphthalein as an indicator.

Take 1g of *Acacia Arabica* seeds powder add 10 ml of distilled water and a few drops of phenolphthalein and while stirring, titrate with sodium hydroxide solution NaOH (0.01N) until a pink color appears.

The titratable acidity expressed as the content of malic acid is calculated by the following formula:

Titratable acidity = V×N×10×FP×100 **(AFNOR, 1974)**

.2.5 Determination of Total sugars

The principle behind the determination of total sugars is based on the following reaction: concentrated sulfuric acid (95%) causes several molecules of water to leave the oses at high temperatures. This dehydration is accompanied by the formation of hydroxy-methylfurfural (HMF) in the case of hexose, and furfural in the case of pentose. These compounds condense with phenol to form colored (yellow-orange) complexes. The intensity of coloration is proportional to the concentration of oses **(Dubois et al., 1956).**

Sugar content is determined using an extraction solvent. A quantity of 1g of grain powder is mixed with 15 ml of 80% ethanol, then the mixture is incubated at 60°C for 15 min in a water bath, then centrifuged at 4000 rpm for 10 min, where the supernatant is recovered **(Kader et al., 1993).**

Using the method of Dubois et al (1956), 0.5 ml of supernatant is mixed with 0.5 ml phenol and 2.5 ml sulfuric acid. After incubation at 30°C for 10 min, absorbance is measured at 490 nm.

Results are expressed in g glucose equivalent per 100g dry matter, based on a calibration curve performed with glucose.

II.3. Biscuit shaping

For Biscuits preparation, the following ingredients are needed:

- 2¼ cups whole wheat flour (200 grams) + a pinch of salt
- 4 tablespoons (50 ml) vegetable oil (fleurial sunflower oil)
- 3 to 4 tablespoons of milk (or plant-based milk)
- 45 grams brown (Sokor vistal brand)
- ¼ teaspoon baking powder
- 9grams of *Acacia arabica* seeds powder

Once the dough was formed, it was rolled out on a surface to a thickness of 0.5 cm. Cookie cutters were used to cut the dough into shapes, ensuring consistency in size and thickness.

II.3.1. Baking of Biscuits

Preheat the oven to 180°C and bake the biscuits in it, study by **(Abd El-Baset and Almoselhy, 2023)** explain that Overheating biscuits can result in the formation of heat-induced contaminants like acrylamide and trans-fats, which can negatively impact their quality and safety. Therefore, baking biscuits at 180°C is a better option to achieve the best quality attributes and consumer acceptance. Place the shaped dough pieces on a parchment paper and make sure to leave a space between each. Bake for 10-12 minutes until its edges turn golden brown. Observe critically for overbaking while the process continues to progress as intended.

II.3.2. Cooling and Storage

After baking, take out the baking tray out of the oven, and then let the biscuits cool down for a good amount of time, This initial cooling helped to set their shape and reduce chewiness. Once cooled, the biscuits were stored in an airtight container to keep them fresh and crisp.

II.3.3. Tasting tests

The tasting test involved 28 untrained panelists who rated the biscuits using the sensory analysis testing test on a scale of 1 to 7 for taste, texture, aroma, and appearance. Each panelist was given a sample of the cookie and instructed to rate each attribute based on pre-defined criteria associated with the scale. **(Bertuzzi and de Lima, 2023).**

II.3.4. Census of the population in question

The untrained panelists were selected in such a way as to include people from a variety of backgrounds so we can have a diverse representation in the sensory evaluation process. Their age ranged from 9 to 59 females and males.

II.4. Sensory Evaluation of biscuits

II.4.1 Methods for assessing the appearance, texture, taste and aroma of prepared biscuits.

Food sensory analysis is a scientific approach that is used to evoke, measure, analyze, and interpret human responses to food products. Senses which are perceived include sight, smell, touch, taste, and hearing, which are used to evaluated important food characters such as appearance, aroma, flavour, texture, sound, or others. Food sensory evaluation of products provides an understanding of the key sensory properties that drive consumer acceptability. It is becoming an important aspect of product quality control, new product development, as well as comparable market research. **(PDST, 2017).**

For each case under investigation, the following questions will need to be answered.

Name :

Age :

Gender :

Table 3: Sensory Analysis.

Sensory Attribute	**Rating**
Apparence	
Color	
Shape	
Surface Texture	
Size	
Aroma	
Intensity	
Flavor	
Sweetness	
Texture	
Crispiness/Crunchiness	
Moistness	
Chewiness	

Table 4 Scoring Guide:

Rating	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Apparence	Very poor	Poor	Fair	Good	V.good	Excellent	Exceptional
Flavor							
Sweetness	None	Minimal.	Slight	Moderate	Balanced	Very sweet	Extremely, overpowering
Aroma							
Intensity	Very faint.	Faint.	Mild, noticeable but not strong	Moderate	Strong, distinctly noticeable	Very strong, highly noticeable	Extremely strong, overwhelming
Texture							
Crispiness / crunchiness	No crispiness	Minimal	Slight	Moderate	Good	Very crunchy	Exceptional
Chewiness	None	Minimal	Slight	Moderate	Good	Very.	Exceptional
Moistness	Very dry, lacks moisture	Minimal moisture	Slightly dry.	Moderate moisture	Moist, balanced	Very moist.	Extremely moist, almost wet

survey :

1. Do you eat sweet biscuits?
   Yes ☐ No ☐
2. What type of biscuits do you eat.(Select all that apply)
   - Dry biscuits
   - Soft cakes
   - Pastry biscuits
   - Wafers
3. Do you choose your sweet cookies based on diet you follow?

   Yes ☐ No ☐
4. How likely are you to try new flavors or varieties of sweet biscuits?
   - Very likely
   - Somewhat likely
   - Neutral
   - Somewhat unlikely
   - Very unlikely
5. How often do you consume sweet biscuits in a typical week?
   - Once a week
   - 2-3 times a week
   - 4-5 times a week
   - Daily
6. When do you eat biscuits.
   - in the morning
   - afternoon
   - nights
7. Do you think the prices of these products are too high?

   Yes ☐ No ☐

Chapter III
Results and discussion

□. Results and discussion

III.1. *Acacia arabica* preparation results.

The seeds were oven-dried at a low temperature 45° to reduce the moisture. This step ensures that the seeds are adequately dried without losing their nutritional value. Or getting damaged by the high heat. Study by **(Oliveira *et al.*, 2021).** Has shown that oven-drying at high temperatures (above 60°C) can cause significant degradation of bioactive compounds like polyphenols, flavonoids, and volatile compounds. The dried seeds were ground using a mechanical grinder and was passed through a fine mesh sieve to remove any larger particles and obtain a uniform particle size.

□.2. Physico-chemical analyses of *Acacia arabica*

□.2.1. Results of moisture content

Moisture and dry matter are two important complementary parameters for food products. Moisture content is an essential parameter for food preservation. High water content leads to rapid spoilage of food products as a result of chemical and enzymatic Chemical and enzymatic reactions and microbial development **(Ribereau, 1968).**

According to the results of the moisture of the seeds and the pods results are obtained:

seeds : WC%= 5.88%. **(Figure 8)**

pods : WC% = 35.71%. **(Figure 8)**

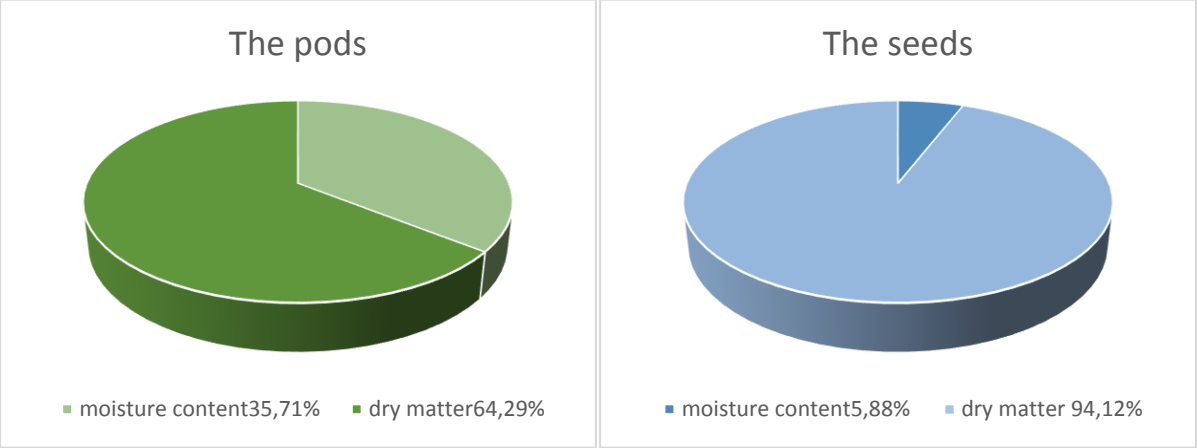

Figure 8 : Pie chart that represent moisture Content of the pods and the seeds.

There is a significant difference in moisture content between the seeds and the pods of *Acacia arabica*. The pods have a much higher moisture content (35.71%) compared to the seeds (5.88%).

The moisture content of the seeds was 5.88%, which is low compared to the moisture content of *Acacia cyclops (9*.3 ± 0.5b%) reported by **(Chong *et al.*, 2019).**

It is closer but slightly lower than the 6.67 ± 0.12% moisture content of A. nilotica results reported by **Ndamitso *et al.*, (2017).** This comparison confirms our results, although the difference is so small that it could be due to differences in environmental growth conditions, harvesting times, or postharvest practices.

In general, our results are consistent with the general trend that acacia seeds have lower moisture content than pods. Seeds are equipped for dry storage and longevity due to structural and physiological differences between seeds and pods.

.2.2 Results of ash (minerals) content

The "ash content" is a measure of the total amount of minerals present within a food, whereas the "mineral content" is a measure of the amount of specific inorganic components present within a food, such as Ca, Na and K. Determination of the ash and mineral content of foods is important for a number of reasons such as nutritional labeling: The concentration and type of minerals present must often be stipulated on the label of a food and quality: The quality of many foods depends on the concentration and type of minerals they contain, including their taste, appearance, texture and stability **(Aryapak and Ziarati, 2014; Ziarati and Ghasemynezhad-Shanderman, 2014)**

To make sure the results are accurate, we have made 3 replicates, before burning: 3.001g, after burning they were estimated to be 0.151g. In percentages, approximately 94.97% of organic matter and only 5.03% of minerals **(Figure 9).**

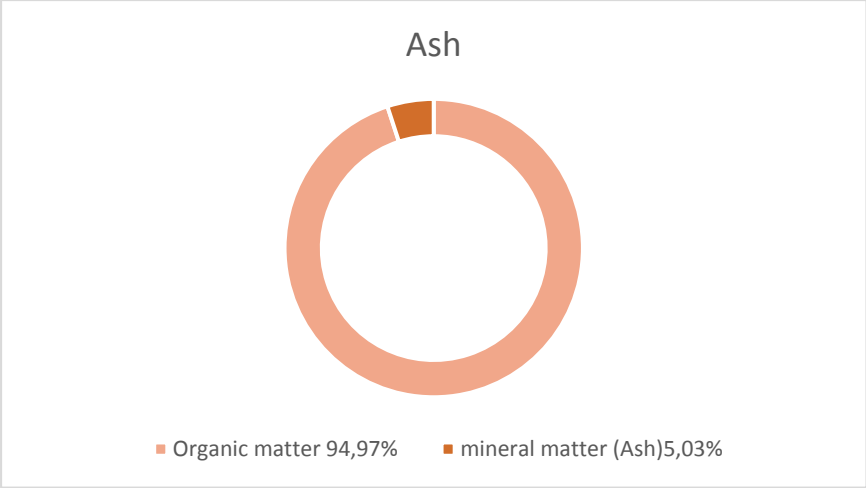

Figure 9 : the organic matter and mineral Matter of A. Arabic seeds.

The ash was approximately 5.03% low in comparison with that of A. Nilotica Seed Growing Wild in South of Iran it's was 13.1% **Ndamitso *et al.*, (2017).**

.2.3.Results of pH

The pH results of Acacia arabica powder were about 4.94. Compared to **(Jebesoa *et al.*, 2023)**, the pH of gum samples from naturally grown Acacia seyal was found to be 4.96.

This pH value is consistent with findings reported in the literature indicating that Acacia arabica seeds typically have a low pH due to the presence of various organic acids. **(Suriati *et al.*, 2023).**

.2.4 Results of Titratable acidity

The titratable acidity of the Acacia arabica solution was determined using a standard titration method. The solution, initially prepared with 1 gram of Acacia arabica powder dissolved in 28 mL of distilled water, was titrated with a standardized sodium hydroxide (NaOH) solution. The volume of NaOH solution required to reach the endpoint was measured, and the titratable acidity was calculated.

The titration resulted In a titratable acidity value of 32.16. This value represents the amount of acid present in the solution. The acidity in Acacia arabica seeds has been attributed to the presence of compounds such as gallic acid, ellagic acid, and tannins.**(Olajuyigbe and Afolayan, 2012).**

The measured titratable acidity falls within a moderate range, indicating neither extremely high nor low acidity. This suggests that the Acacia arabica solution may exhibit moderate acidic properties, which could be relevant for various applications such as food processing or pharmaceutical formulations.

The pH and titratable acidity were calculated together because they provide complementary information about the acidity of the seed powder. While pH indicates the immediate acidity level, titratable acidity measures the total acid content. Together, they help assess how the seed powder will influence the flavor, texture, and stability of the biscuits.

.2.5. Total sugars results

The total amount of sugars in Acacia arabica seeds was performed using spectrophotometry analysis. The absorbance medium value obtained from the spectrophotometric measurement was 0.371. Using the provided calibration equation (Y = 103.9X + 0.023), the concentration of sugars in (g/mL) was calculated reporting to a calibration curve of standard solution (Figure 10) using the equation:

Y=103.9x +0.023

X=3.3 mg/ml (dilution ×2) X=6.6 mg/ml

In another study, **Falade *et al.*, (2005)** have reported a total amount of sugar content of Acacia species seeds grown in Niger was determined separately that ranged from 13.8 to 15.5 (g/100 g).

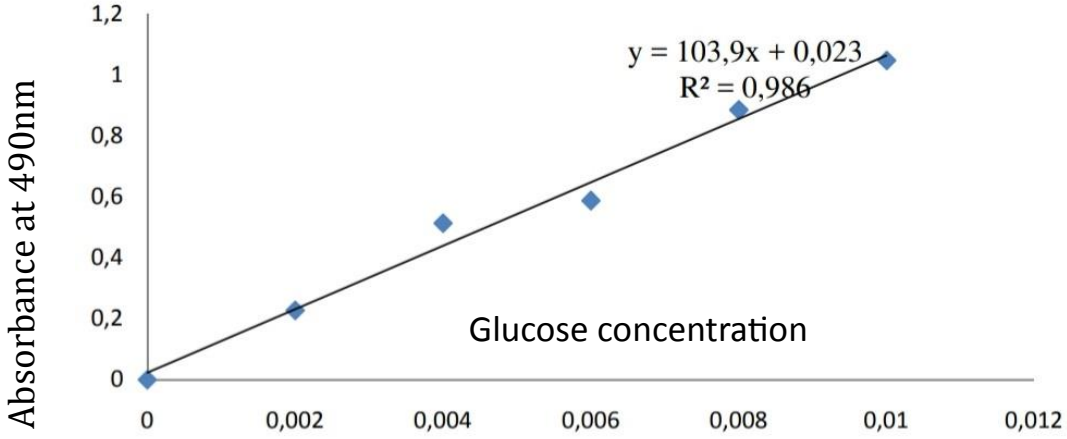

Figure 7: calibration curve of sugars

.3. Biscuit shaping

The ingredients and proportions facilitated the formation of a dough suitable for rolling and cutting. The uniformity of the dough consistency contributed to consistent cookie shapes, essential for even baking and aesthetic appeal.

.3.1. Baking of Biscuits

With regard to the method described, the biscuits were baked at 180°C for 12 minutes. The biscuits baked to a golden brown color and had a relatively good appearance with slightly different textures in different batches after baking. It also retains its size even when cooked. **(Figure 11).** The seed powder did not make a big change in the test or the size of the cookies.

Figure 10: *Acacia Arabica s*eeds powder biscuits (19/05/2024)

The research carried out by **Ivanišová *et al.*, (2019)** on the physicochemical and sensory evaluation of biscuits enriched with chicory fiber supports the positive impact of incorporating fibrous ingredients on the sensory and nutritional profile of biscuits Compared to the Acacia Arabica biscuits in this study, this is in line with the overall trend of using plant-based ingredients to improve the sensory and nutritional attributes of baked goods.

.3.2. Cooling and Storage

Observations made during cooling showed textural solidification and an increase in the structure of the biscuits. Analyses of the changes in texture and flavor of the products throughout the storage period also showed small changes, indicating good shelf life.

.3.3. Census of the population in question

The sensory test was carried out by 28 untrained panelists, aged between 9 and 59, including seven (7) males and twenty-one (21) females (N = 28), randomly selected from a wide range of family, friends and acquaintances. The most represented age group is that of subjects aged between 18 and 25 years old (46% of the total) .

Table 5: Total population distribution by age

Category	**Sub-category**	**Number of Participants**	**Percentage (%)**
Total Participants		28	100%
Gender	Females	21	75%
	Males	7	25%
Age Group	Children (9-12 years)	3	11%
	Young adults (18-25 years)	13	46%
	Adults (26-50 years)	6	21%
	Seniors (51+ years)	6	21%

□.4. Sensory evaluation of biscuits results

□.4.1 Results for appearance, texture, flavor and aroma of prepared biscuits.

Table 6: Summary of average sensory attribute ratings with standard deviations

Attributes	(Avg±SD)
Color	5.00 ± 0.92
Shape	6.00 ± 0.58
Surface Texture	5.27 ± 1.03
Size	5.20 ± 1.01
Aroma intensity	5.29 ± 0.51
Sweetness	4.00 ± 0.66
Crispiness/Crunchiness:	4.00 ± 0.83
Moistness	4.64 ± 0.45
Chewiness	4.67 ± 0.49

The overall results suggest mixed opinion about each attribute, with the shape scoring the highest score (6.00 ± 0.58), suggesting that the panelists found the shape to be highly satisfactory. The crispiness and the sweetness had the least score on all of them were rated at 4.00 ± 0.66 and 4.00 ± 0.83. the biscuits had slight to moderate sweetness for the purpose of making it more healthy and fit the Diet. Surface texture and size received average scores of 5.27 ± 1.03 and 5.20 ± 1.01 respectively, showing moderate approval. Aroma had a mixed opinion was rated at 5.29 ± 0.51, for some it's was overwhelming and other didn't mind it at all. Moistness and chewiness were rated at 4.64 ± 0.45 and 4.67 ± 0.49, indicating a slight preference towards a moist and chewy texture.

Overall this was influenced by the the fibrous nature and binding properties of the powder. According to a study by **Kwofie *et a.*, (2023)**, the sensory evaluation and acceptability of vegetable biscuits indicated that the inclusion of plant-based ingredients can enhance sensory characteristics, making the biscuits more appealing to consumers.

In a recent study by **Nurul Hafizah Mohd Yasin *et al.*, (2023)**, high-fiber biscuits were developed using brown rice and banana peels. This study demonstrated that the inclusion of fiber-rich ingredients significantly improved the nutritional profile of the biscuits without compromising their sensory acceptability. The modified biscuits were well-received by

consumers, highlighting the potential for integrating healthier ingredients into traditional biscuit formulations to enhance their health benefits.

These studies are in line with the concept we intend to adopt in the formulation of less sweet and more fiber enriched biscuits. The findings of both the studies revert with our results and it was revealed that consumers are inclined to accept low positive discriminating sensory biscuits beneficial in health aspects. When comparing our findings with these researches, one can clearly establish that, its possible to upgrade various parameters of biscuits, including nutrient density, with the use of healthier ingredients, including plant components and high-fiber replacements, while simultaneously increasing or at least maintaining consumers' satisfaction.

Survey results

Out of the respondents, 85.71% indicated that they consume sweet biscuits and do enjoy them, the other said they are not a big fan and rarely eats them. Dry biscuits were the most commonly consumed type, with 54% of respondents choosing them.Soft cakes were favored by 43%.Pastry biscuits and wafers were chosen by 32% and 25% of respondents, respectively.

A significant portion of respondents (50%) consumed biscuits In the morning, while 32% preferred them in the afternoon, and 18% indulged at night.

The frequency of sweet biscuit consumption varied:25% consumed them once a week.39% consumed them 2-3 times a week.21% consumed them 4-5 times a week.14% consumed them daily.

Regarding dietary considerations, 61% of respondents stated that they do not choose their sweet biscuits based on their diet, while 39% indicated otherwise.

A majority of respondents (65%) expressed a positive attitude towards trying new flavors or varieties of sweet biscuits:29% were very likely to try new flavors.36% were somewhat likely.18% were neutral.11% were somewhat unlikely.7% were very unlikely.

When asked about their perception of the prices of sweet biscuits, 82.14% of respondents considered them reasonable. However, 17.86% found them to be high. Notably, responses varied, with many stating that their opinion depended on the brand.

Conclusion

In this Research, we looked into the physical and chemical traits of Acacia arabica and how it can be used in making biscuits, particularly focusing on sensory analysis done by different people with different backgrounds and age. With 28 untrained panelists The overall results of the sensory analysis suggest mixed views about each attribute. The Acacia arabica seed powder showed notable characteristics: a titratable acidity of 32.16, a pH of 4.94, 94.97% organic matter, 5.03% ash content, and a total sugar concentration of 3.3 mg/ml. These findings suggest that the *acacia arabica* has potential as a beneficial ingredient in food products. And it's not harmful.

The integration of Acacia arabica seed powder into biscuit formulations not only enriches the nutritional profile but also aligns with current consumer preferences for wholesome and innovative food choices. This study contributes valuable insights into utilizing natural ingredients to enhance food quality, setting a foundation for future advancements in functional food development and consumer-oriented nutritional strategies.

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