Investigation of Antimicrobial and Health Promoting Potential of African Indigenous Spices

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Abstract**—**Indigenous African spices are gaining recognition for their potential as natural antimicrobial and health promoting agents in modern food systems. This study investigated the antimicrobial efficacy and bioactive compound profiles of four spices i.e. Djansang (*Ricinodendron heudelotii*), Pebe (*Scorodophloeus zenkeri*), 4 coté (*Tetrapleura tetraptera*), and country onion (*Afrostyrax lepidophyllus*) cold and hot water extraction methods. Extracts were evaluated for growth inhibition activity against a range of microorganisms, including various yeast species, bacteria, and moulds. African spices were subjected to cold and hot water extraction methods and the cold-water extracts from Djansang demonstrated significantly higher inhibitory activity against yeasts such as *Zygosaccharomyces* spp. compared to hot water extracts. Djansang hot extracts exhibited minimal antimicrobial effects. Additionally, the spices were incorporated into processed tomato sauce and Achu soup formulations to assess their impact on product shelf life and nutritional quality. Microbial analyses indicated that tomato sauce treated with heat and potassium sorbate remained safe for consumption for 12 weeks, while Achu soup showed enhanced stability when subjected to additional heat treatment. Reverse phase high performance liquid chromatography with photodiode array detection (RP-HPLC-PAD) identified key bioactive compounds, including vanillic acid, quercetin, caftaric acid, catechin, and epicatechin gallate. These phenolic compounds confirm the potential antioxidant and anti-inflammatory properties of Djansang (*Ricinodendron heudelotii*), Pebe (*Scorodophloeus zenkeri*), 4 coté (*Tetrapleura tetraptera*), and Country onion (*Afrostyrax lepidophyllus*. Overall, these findings tent to support the application of indigenous African spices as natural antimicrobial agents and functional food ingredients, necessitating further research into optimizing extraction and cooking processes to maximize their therapeutic benefits. These findings lay groundwork for sustainable and healthier global food innovations.

Keywords**—**Indigenous African Spices, Antimicrobial Activity, Bioactive Compounds, Functional Foods, Natural Preservatives

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I. Introduction

In recent years, the food industry has witnessed a paradigm shift towards the development of products derived from natural resources, including indigenous African spices, to address malnutrition and enhance the health-promoting properties of processed foods [1]. This transition is driven by a growing consumer demand for healthier food options and the imperative for innovative and sustainable approaches to food production. Indigenous African spices have emerged as promising sources of bioactive compounds that not only enrich the nutritional content of foods but also offer potential health benefits [2]. Indigenous African spices, renowned for their aromatic and flavor-enhancing qualities in traditional cuisines, are increasingly recognized for their medicinal properties [3]. These spices contain numerous bioactive compounds with anti-inflammatory, antioxidant, antitumorigenic, and anticarcinogenic properties, contributing to their therapeutic potential [4]. For instance, Djansang (*Ricinodendron heudelotii*) has been extensively utilized in African traditional medicine to alleviate various ailments including anemia, stomach aches, coughs, fevers, dysentery, malaria, and infertility [5]. Notably, in Cameroonian traditional medicine, Djansang spice is frequently prescribed for managing cardiovascular conditions such as hypertension, underscoring its therapeutic versatility [5]. Another indigenous spice of significant medicinal value is Country onion (*Afrostyrax lepidophyllus*), found abundantly in the forests of Cameroon, Ghana, and the Republic of Congo [6]. The seeds of this plant, commonly utilized as spices in African culinary practices, possess a distinct pungent garlic or onion odour and have been traditionally used for their medicinal properties. The diverse array of bioactive compounds present in Country onion seeds underscores their potential in combating various acute and chronic illnesses prevalent in African communities [7], [8].

Despite the increasing interest in the health-promoting potential of indigenous African spices, significant challenges persist in harnessing their bioactivity effectively in food systems [1]. Achieving optimal concentrations of bioactive compounds while ensuring their preservation during food processing, packaging, and storage remains a formidable task.

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The delicate balance between retaining the bioactivity of these ingredients and meeting consumer preferences for taste and sensory attributes presents a multifaceted challenge for food scientists and researchers. This study seeks to address these challenges by investigating the antimicrobial and health-promoting potential of four indigenous African spices. Through an examination of their antimicrobial properties against selected organisms and the analysis of the bioactive compounds present in these spices, this research aims to elucidate the preservative potential and use in functional food products that align with consumer preferences for healthier food options. By elucidating the therapeutic benefits of indigenous African spices and their applications in food production, this study endeavours to promote public health and well-being in African communities and beyond.

II. Materials and Methods

A. Sourcing of spices and water extraction

Four dried spices were procured from retail shops in Cape Town, South Africa i.e. Djansang (*Ricinodendron heudelotii*), Pebe (*Scorodophloeus zenkeri*), 4 coté (*Tetrapleura tetraptera*), and Country onion (*Afrostyrax lepidophyllus*). For the water extraction process, 20 g of each dried and milled spice was placed in a 250 mL Erlenmeyer flask, and 100 mL of distilled water was added. The mixtures were vigorously stirred manually and allowed to stand at approximately 25°C for 24 hours. Subsequently, the solutions obtained were centrifuged at 5000 rpm for 15 minutes at 14°C and filter sterilized using 0.22 µm syringe filters to eliminate microbial contaminants. Additionally, hot extraction was performed by placing 20 g of each dried spice in a 250 mL Erlenmeyer flask, adding 100 mL of distilled water, and manually stirring the suspension. The suspension was then autoclaved at 121°C for 15 minutes, followed by centrifugation at 5000 rpm for 15 minutes at 14°C in an Avanti centrifuge (Beckman-Coulter, Johannesburg, South Africa). The supernatant (crude compounds) of each spice was filter sterilized using 0.22 µm syringe filters. Importantly, both cold and hot water extraction approach was employed to bring the experiment as closer as possible to way they have been prepared and used as it has been anecdotally claimed.

B. Microbial origin and culture conditions

The spoilage microorganisms were sourced from the culture collection of the Agricultural Research Council, ARC Infruitec-Nietvoorbij, Stellenbosch, South Africa. These included Gram-positive and Gram-negative bacteria such as *Staphylococcus aureus*, *Bacillus cereus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Additionally, spoilage yeasts such as *Meyerozyma guilliermondii* (anamorph *Candida guilliermondii)*, *Zygosaccharomyces fermentati*, *Zygosaccharomyces florentinus*, *Zygosaccharomyces rouxii*, *Pichia fermentans* (anamorph *Candida lambica)*, *Zygosaccharomyces microellipsoides*, *Zygosaccharomices cidri*, *Dekkera bruxellensis*, *Zygosaccharomyces bailli*, and *Dekkera anomala*, as well as moulds such as *Botrytis cinerea*, *Alternaria stolonifer*, and *Penicillium expansum* were used. Yeast cultures were prepared by transferring a wire loop full of each yeast colony into 5 mL of yeast malt broth (YMB, Merck, South Africa) and incubating at 28°C for 48 hours. Similarly, bacterial cultures were prepared by transferring a wire loop full colony of each bacterium into 5 mL of MRS broth, (Biolab, Merck, South Africa) and incubating at 28°C for 48 hours. Mould cultures were sub-cultured on potato dextrose agar (PDA, Merck) and incubated at 25°C until sufficient growth was obtained and ready to use for follow-up experiments.

C. Microbial seeding and antimicrobial assay

Fully-grown plates containing pure colonies of the selected microorganisms were used for microbial seeding. Yeast cultures were adjusted to a concentration of 106 cells/mL in grape pomace juice, while bacterial cultures were seeded at a volume of 100 µL in 25 mL of grape pomace juice. Mold inoculums were prepared by suspending spores in sterile water, adjusting to a concentration of 10^5 spores/mL, and then seeding in 25 mL of grape juice. A volume of 5 mL four-time strength agar bacteriological was mixed with the 25 mL grape juice, and 10 mL was poured onto 90 mm Petri dish and allowed to solidify. The volumetric zone of inhibition (VZI) concept was used for the antimicrobial activity quantification. The VZI is a concept used to assess how effective an antimicrobial agent is at preventing the growth of an organism. It is based on measuring the area and thickness of the agar medium around a well where the compound has been applied and then estimating the volume of that inhibited region. In this case, 10 µL of extract was inoculated into a 5 mm well in grape pomace extract agar, as described by Mewa Ngongang [9]. A clear zone around the well indicated microbial growth inhibition. By determining the surface area of this zone and multiplying it by the thickness of the agar, the volume of inhibited medium is calculated. This volume reflects the effectiveness of the antimicrobial agent being tested. The result is expressed as the volume of contaminated solidified media controlled per millilitre of antimicrobial compound/agent used. A higher VZI value indicated a more potent or effective antimicrobial agent. Each spice extract sample was spotted in triplicate. Plates were incubated at 22°C for 3 to 5 days until clear zones around the wells were observed.

D. Health promoting properties investigation

1) Application of indigenous African spices in tomato based and indigenous soup, Achu

The tomato sauce preparation began by following a standardized recipe, containing the specific mass of dried spices; 18 g Djansang (*Ricinodendron heudelotii*), 125 g Country onion (*Afrostyrax lepidophyllus*), 23 g 4 Cote (*Tetrapleura tetraptera*), and 10 g Rondelle arachide (*Scorodophloeus zenkeri*). The difference in the amount of spice used was recipe dependent but remain within an acceptable and edible dose. The mixture was subjected to conventional cooking at 100°C for 45 minutes. Prior to cooking, 14 kg of tomatoes were rinsed, blended, and boiled for 10 minutes. After adding the dried ingredients and flavoring, the tomato sauce was cooked further for 10 minutes and canned immediately. Three treatments were prepared post-cooking: the first included 12 cans (canned and sealed) of tomato sauce with a concentration of 500 mg/kg potassium sorbate (PS) added as preservative according to industrial standard; the second comprised 23 cans of tomato sauce subjected to heat treatment at 70°C for 20 minutes (no PS); and the third involved 23 cans of sauce subjected to further heat treatment at 100°C for 20 minutes (no PS). Samples were incubated at 50°C and plated out every week for 12 weeks to evaluate the microbial stability and shelf life thereof. While a specific recipe was followed in this study, the primary objective was to evaluate the presence of health-promoting compounds at the spice concentrations used, and similar assessments can be replicated using any preferred formulation.

Regarding Achu soup preparation and treatments, flavouring agents (15 g food grade Bicarbonate of soda, 2.6 g Monosodium glutamate, and 11 g Salt) were added to the soup. Dried spices (2.3 g *Tetrapleura tetraptera*, 2.3 g *Scorodophloeus zenkeri* and 3 g *Afrostyrax lepidophyllus*) and 1.7 g white pepper were combined with 60 mL of palm cooking oil and 750 mL of domestic tape water, autoclaved, and mixed under sterile conditions. Two treatments were prepared: one without preservatives and the other with potassium sorbate as preservative at 1350 mg/kg. Both were incubated at 4°C and plated out weekly to assess the microbial and product stability to determine after how long the product would still be safe for consumption. A second batch followed similar procedures, but with additional heat treatment for the purpose of increasing the ability to be free of microbial contaminants by placing the jars in 100°C water for 20 minutes before incubation. In the second trial, preparations were conducted under sterile conditions without using a blender. Two treatments, one with no preservative and the other with potassium sorbate, were mixed using sterile bottles, incubated at 4°C, and plated out weekly for microbial analysis. Both batches were later incubated at 28°C for microbiological examination after 14 days. It is important to note that the platting technic employed made use of serial dilutions in a 0.8% saline solution and the PCA, VRBA and WL media. To maintain focus on bioactive compounds presence, it is worth noting that any equivalent Achu formulation could be used to replicate this work, as the study emphasized evaluating microbial stability and bioactive compounds retention at the spice concentrations used.

2) *Bioactive compounds analysis*

The use of a reverse phase high performance liquid chromatography photodiode array detection (RP-HPLC-PAD) in the current study permitted the identification and quantification of phenolic and antioxidant compounds [10], [11]. Separation was achieved using a C18 reverse-phase column with a gradient elution of acidified aqueous and organic solvents at a flow rate of 0.8–1.0 mL/min, and detection was carried out across 200-400 nm using a photodiode array detector. The compounds were separated and measured by utilizing calibration curves with commercial standards and ultraviolet absorbance patterns. Prior to HPLC examination, water-extracted crude spice samples underwent filtration through a 0.22 µm nylon membrane syringe filter.

3) *Shelf-life determinations*

For shelf-life studies, media including PCA, VRBA, and WL were used to assess bacteria, yeast, and mould presence. Samples were randomly taken and plated out using these media, in triplicate. The treatments included tomato sauce with potassium sorbate, tomato sauce heat-treated at 70°C and 100°C, and Achu soup with and without potassium sorbate. Plating involved serial dilution, with 1000 mL sample diluted to 9 mL saline until concentration dilution of 10^{-5} was achieved, then plated out accordingly.

III. RESULTS

A. *Antimicrobial potential*

This part of the study was conceptualised to evaluate the potential microbial growth inhibitory effects of extracts derived from Djansang (*Ricinodendron heudelotii*), Pebe (*Scorodophloeus zenkeri*), 4 coté (*Tetrapleura tetraptera*), and Country onion (*Afrostyrax lepidophyllus*) using volumetric zone of inhibition (VZI) assays. It is important to highlight that, any observed zone of inhibition demonstrates growth inhibition effect and may vary depending on the sensibility of the tested microorganisms. Out of the various spice extracts tested, cold extract crude samples exhibited the highest level of inhibition against *Zygosaccharomyces rouxii*, *Z. microellipoides* and *Z. cidrii*, with VZI values of 0.13, 0.07, and 0.03 L CSM/mL ACU, respectively (Fig. 1a). Hot extract crude samples also demonstrated growth inhibition activity against *Z. cidrii* and *Z. microellipoides* with VZI values of 0.00083 and, 0.00087 L CSM/mL ACU respectively (Fig. 1b). A much broader and higher growth inhibition was observed with cold extract crude samples against *Z. rouxii*, with a reduced inhibition effect observed against *Z. cidri*. Conversely, hot extract crude samples did not show any inhibition against *Z. rouxii* but displayed a broader inhibition profile against *Z. cidri* with a narrow inhibition activity against *Z. microellipoides*. However, neither cold nor hot extract samples showed visible efficacy against bacterial or mould growth.

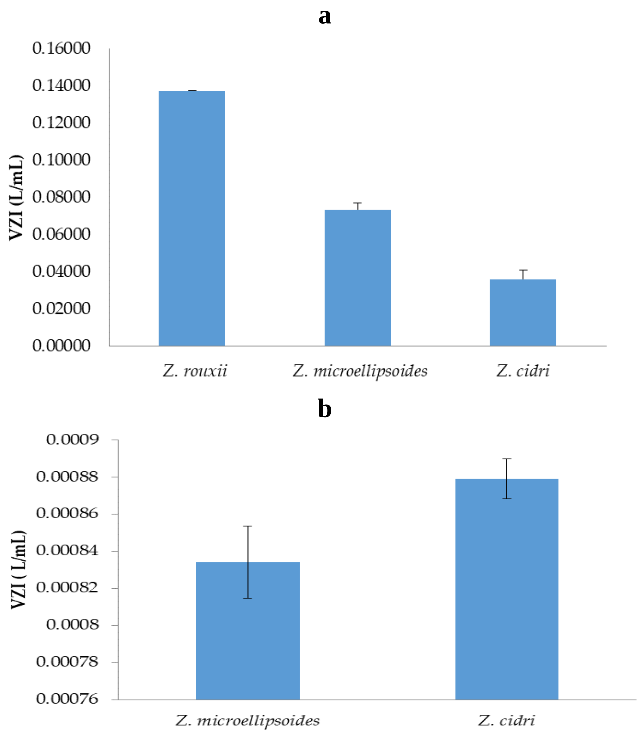

Fig. 1 The *Tetrapleura tetraptera* growth inhibition activity of 20 % cold water extracted crude (a) against *Zygosaccharomyces rouxii*, *Zygosaccharomyces microellipsoides*, *Zygosaccharomyces cidri* and 20 % hot water extracted crude (b) against *Z. cidri* and *Z.s microellipsoides*. Values are the average of replicates consisting of three independent repeats ± standard deviation

Consistent with the preceding procedure, *Candida guilliermondii*, *Dekkera anomala*, *Dekkera bruxellensis*, *Zygosaccharomyces bailii*, *Z. microellipsoides*, *Z. rouxii*, *Z. bisporus*, *Z. fermentati*, *Z. cidrii*, and *Z. florentinus* were used as sensitive organisms to test the antimicrobial potential of *Ricinodendron heudelotii*. In ascending order, growth inhibition activity was observed with VZI values of 0.2124, 0.2058, 0.07266, 0.06597, 0.05866, and 0.01196 L CSM/mL ACU respectively for sensitive organisms *D. bruxellensis*, *Z. fermentati*, *Z. florentinus*, *D. anomala*, *Z. rouxii*, and *Z. microellipsoides*. Interestingly hot extracted crude sample did not demonstrate any inhibition activity against the tested microorganisms, whereas cold extract crude samples showed a total opposite of the hot crude extract sample by inhibiting 6 of the 10 strains tested. This finding may suggest that the indigenous approach to the cold preparation of medicinal tea for treatment of various ailments and diseases may be scientifically valid given the current findings. Out of the selected spices, *Ricinodendron heudelotii* showed a broader growth inhibition activity. *Ricinodendron heudelotii* was also tested against bacteria and moulds, and both hot and cold crude extract samples did not show observable inhibition activity against any of the selected bacteria or mould strains tested. Fig. 2 below illustrates the observed growth inhibition expressed in L CSM/mL ACU *Ricinodendron heudelotii* against the selected yeast species.

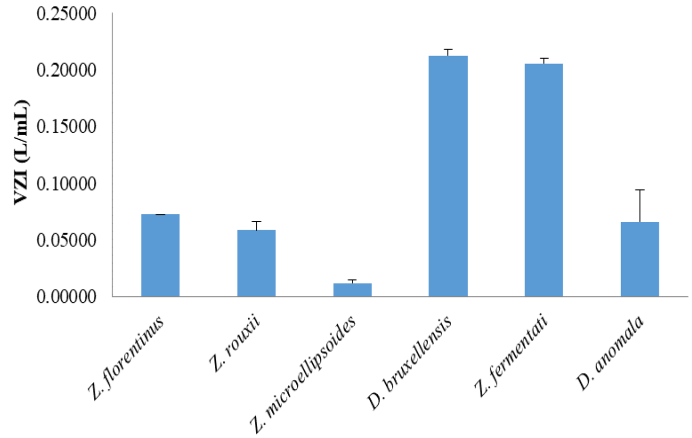

Fig. 2 The growth inhibition activity of 20 % cold water extracted crude *Ricinodendron heudelotii* tested against *Dekkera anomala*, *Dekkera bruxellensis*, *Zygosaccharomyces microellipsoides*, *Z. rouxii*, *Z. fermentati*, and *Z. florentinus.* Values are the average of replicates consisting of three independent repeats ± standard deviation

In addition, the same procedure was done using the same species to test the antimicrobial potential of Pebe (*Scorodophloeus zenkeri*) and Country onion (*Afrostyrax lepidophyllus*). However, both hot and cold extract crude samples of both spices did not demonstrate any inhibition activity against the yeast species, bacteria and moulds tested.

B. Health promoting properties outcomes in different food products

1) Processed tomato-based sauce

Before analysing the presence of health-promoting compounds, it was essential to evaluate the stability of the processed foods containing the selected spices. In food industry, as well as in this study, the level at which food is believed to be safe for consumption is when the total microbial count is less than 100 CFU/mL for bacteria, yeast and mould [13]. In Fig 3a, the increase in aerobic bacterial count indicates that the tomato sauce was unsafe after week 13 when exposed to 70°C and 100°C, as the microbial count exceeded 100 CFU/mL. This study did not discover microbial development in tomato sauce treated to 100°C temperatures. However, a notable reduction in microbial count was found after week 7 of the treatments, followed by an increase in microbial count during week 12 in the tomato sauce samples treated with potassium sorbate.

The tomato sauce platted on WL media was deemed safe for consumption for around 12 weeks when exposed to 70°C and treated with potassium sorbate, as the counts of yeast, mould, and bacteria were below 100 CFU/mL (Fig 3b). On the other hand, the tomato sauce heated to 100°C remained safe for consumption for approximately 7 weeks, as the microbial count was below 100 cfu/mL. In contrast to other treatments, this tomato sauce was deemed unsafe for consumption by week 12, with microbial counts exceeding 100 CFU/mL. The three treatments showed signs of instability as the bacteria count increased over time.

The tomato sauce platted on VRBA was safe for consumption for about 12 weeks when subjected to 100°C and potassium sorbate treatments as the coliform organisms count present was less than 50 CFU/mL (Fig. 3c). However, the tomato sauce subjected to 70°C was not safe for consumption on week 3 as the microbial count was more than 50 CFU/mL. In addition, there was a gradual reduction in the total bacteria count across all three treatments.

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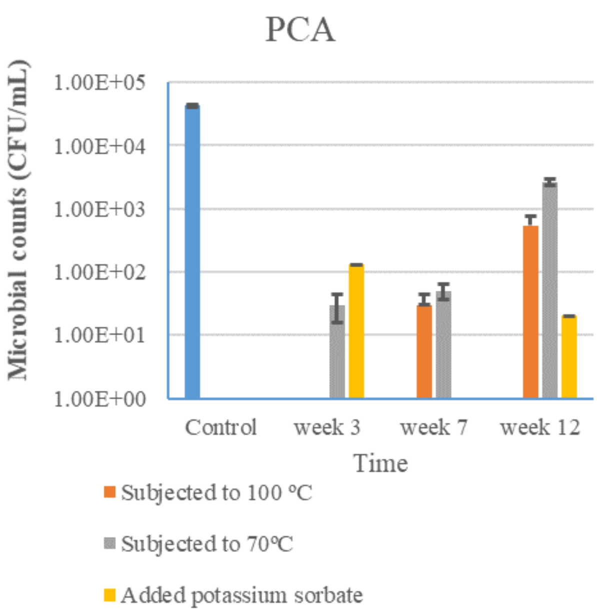

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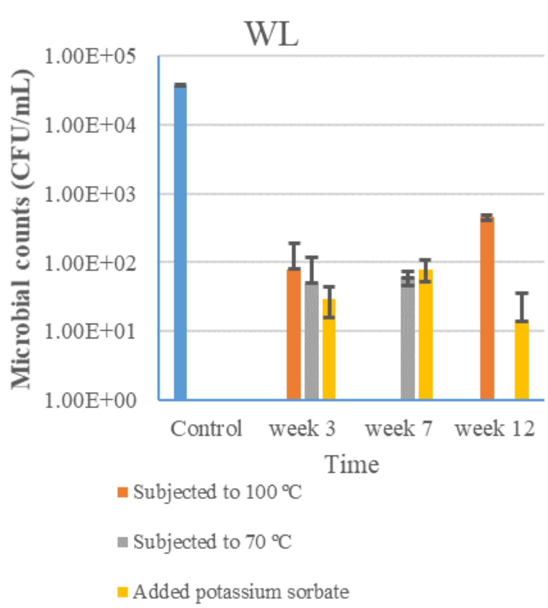

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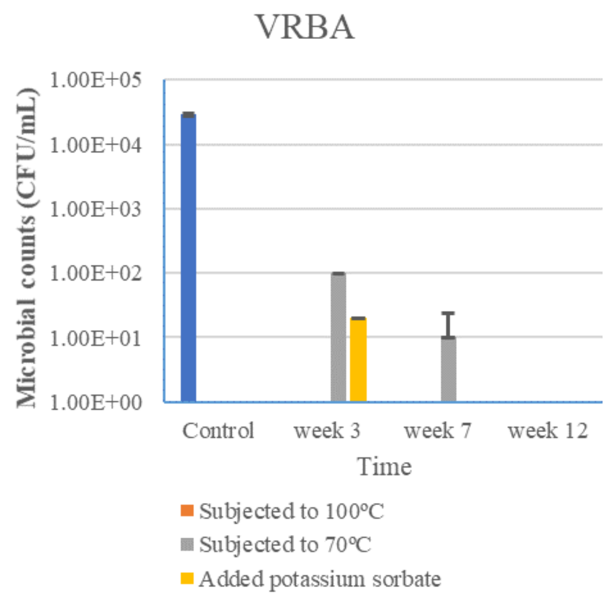

Fig. 3 Microbial growth on PCA (a), WL (b), VRBA (c) of accelerated shelf-life study of tomato sauce incubated at 50°C. Two different treatments i.e., 70°C, 100°C were used along with a negative (unprocessed product) and positive control (addition of potassium sorbate), and evaluated weekly. The values presented on the graphs are the average of three replicates.

2) Processed Achu soup

Achu soup is a traditional African indigenous soup used for cold and flu. The following results shows the shelf-life stability study of Achu soup incubated at 4°C in the fridge. Achu soup treated with potassium sorbate was deemed unsafe for consumption as the aerobic bacteria count exceeded 100 CFU/mL, whereas Achu soup that was not treated with chemical preservative seemed safe for consumption on week 0 as the microbial count **was less than 100 CFU/m (Fig.** 4a). An increase in the microbial count of non-preservative treatment was observed after week 1 making the soup not safe for consumption while a decrease was observed in the microbial count of the potassium sorbate treatment making the soup safe for consumption as the microbial count was less than 100 CFU/mL. An increase in the microbial count in both treatments was observed on week 2 and 4 making soup unsafe for consumption.

Achu soup presented on WL with non-preservative treatment was deemed unsafe for consumption due to a microbial count exceeding 100 CFU/mL, whereas the preservative treatment exhibited a microbial count below 100 CFU/mL at week 0, rendering it safe for consumption (Fig. 4b). An overnight rise in microbial count during weeks 2, 3, and 4 rendered the soup unsafe for consumption as well. Unsurprisingly, the untreated soup exhibited a higher microbial count than the treated soup. Achu soup with no of chemical preservatives was deemed unsafe for consumption from week 0 to week 4 due to a microbial count over 50 CFU/mL consistently, indicating an escalating microbial

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presence over time. Achu soup preserved with potassium sorbate was deemed safe for consumption at week 0, as no microbial growth was detected (Fig. 4c). However, a rise in microbial count from week 1 to week 4 was noted, rendering the soup unsafe for consumption. Additionally, the soup treated without preservatives exhibited a higher microbiological count compared to the treated soup.

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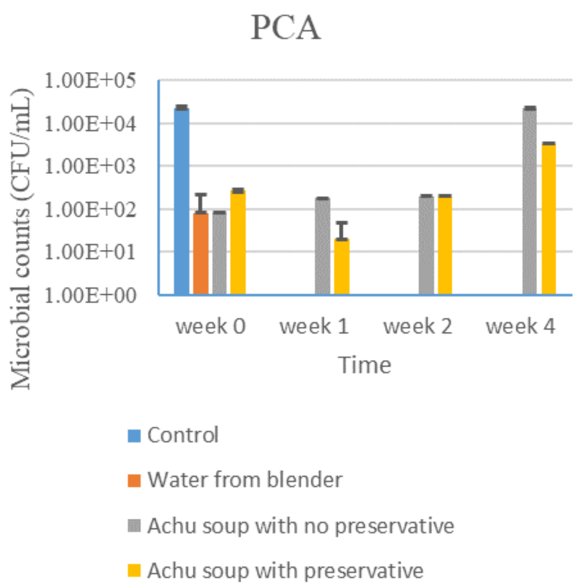

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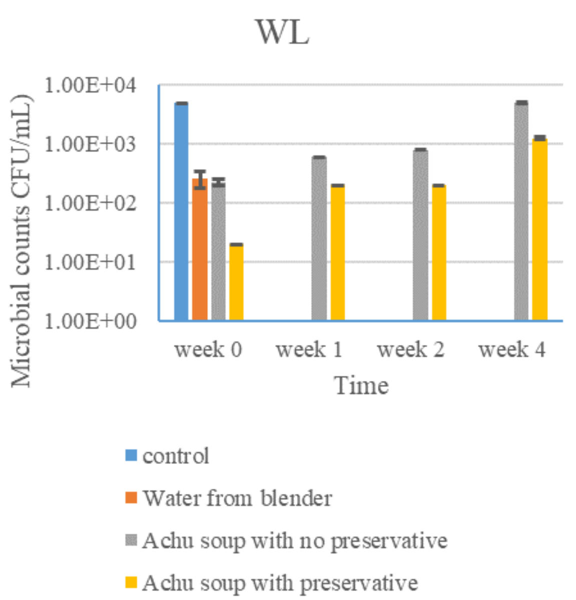

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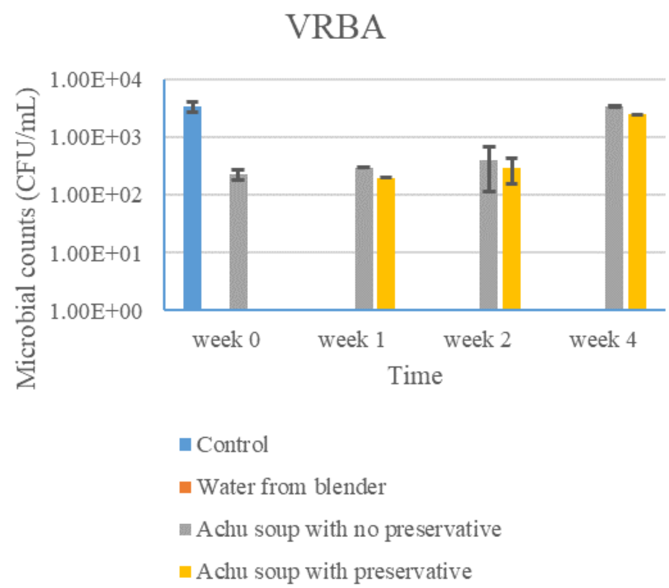

Fig. 4: Microbial growth on PCA (a), WL (b), VRBA (c) during shelf-life study of Achu soup incubated at 4℃ and evaluated weekly. The values presented on the graphs are the average of three replicates

In Fig 5a, Achu soup platted on PCA for both treatments was safe for consumption for about 4 weeks as the microbial count was less than 100 CFU/mL. A decrease of microbial count of non-preservative treatment was observed on week 2, which resulted in a completely safe product for consumption as no microbial growth was observed on week 4 in the soup. The soup treated with potassium sorbate showed no microbial growth from week 2 and was stable till week 4 making the soup shelf stable for more than 4 weeks. In Fig. 5b, Achu soup platted on WL for both treatments were safe for consumption for about 4 weeks as the microbial count was less than 100 CFU/mL. A decrease in microbial count of non-preservative treatment was observed on week 2 and 4. The soup treated with potassium sorbate was totally safe for consumption on week 2 and 4 as no microbial growth was observed on soup. In Fig. 5c, Achu soup platted on VRBA for both treatments there was no contamination observed for more than 4 weeks. These results further provide significant insights into the approach that can be used to ensure safe and shelve life stable Achu which will allow a more appropriate and adequate use in households and domestic settings in rural and modern communities.

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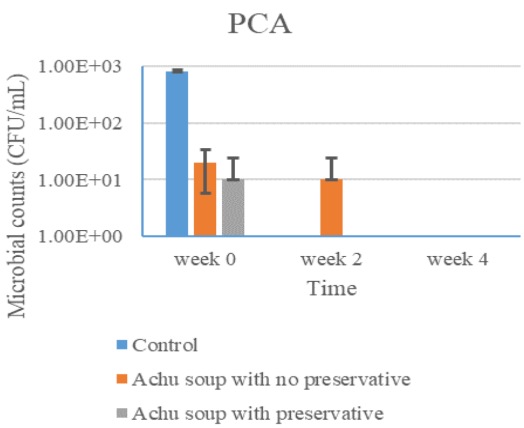

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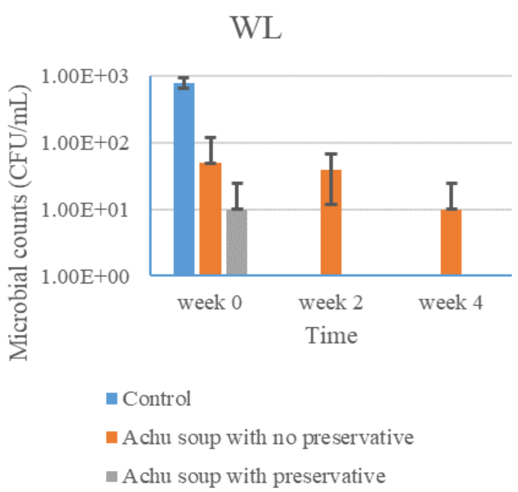

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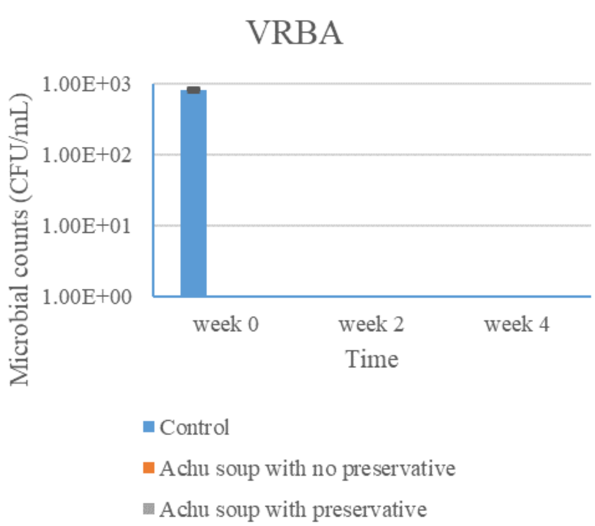

Fig. 5 Microbial growth on PCA(a), WL (b), VRBA (c) during shelf-life study of Achu soup prepared without the use of a blender and incubated at 4℃ and evaluated weekly. The values presented on the graphs are the average of three replicates.

3) Health promoting potential

In the spice-mix tomato sauce samples, three compounds vanillic acid, quercetin, and caftaric acid, were identified. These compounds are mostly known for their antioxidant and anti-inflammatory capabilities. In comparison to vanillic acid and caftaric acid, quercetin was found at higher concentrations (6,5 mg/L). In the processed tomato sauce preserved with potassium sorbate, three compounds—catechin, epicatechin gallate, and caftaric acid—were discovered. These chemicals are mostly recognised for their antioxidant properties. Catechin (9 mg/L) was identified at elevated amounts relative to epicatechin gallate and caftaric acid. In the prepared Achu soup preserved with potassium sorbate, three compounds—epicatechin gallate, quercetin, and catechin—were discovered. These chemicals are mostly recognised for their antioxidant properties. Quercetin (6.9 mg/L) was identified at elevated amounts relative to epicatechin gallate and catechin. Certain substances necessitate precise dietary amounts to provide health advantages; for instance, 6.9 mg/L of quercetin is required.

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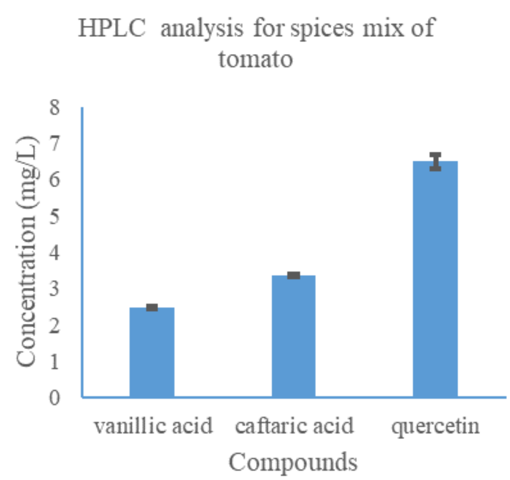

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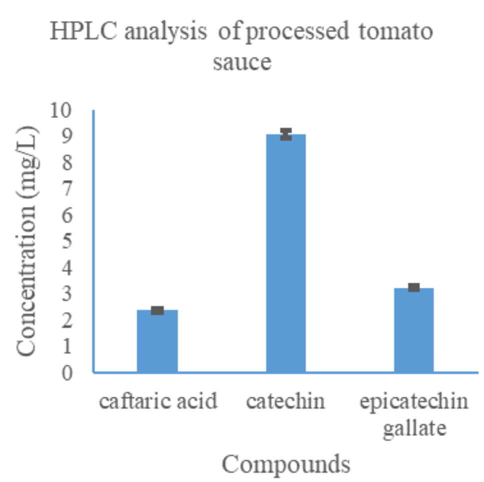

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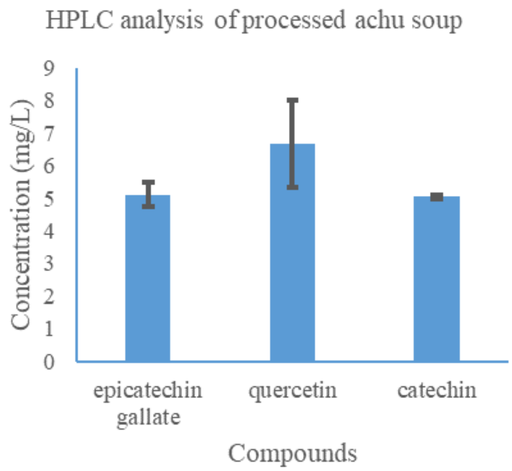

Fig. 6 Results of the reverse phase high performance liquid chromatography photodiode array detection (RP-HPLC-PAD) for the identification and quantification of health promoting compounds present in (a) Mix spices used in the tomato based sauce, (b) process tomato sauce, (c) processed Achu soup. The values presented on the graphs are the average of three replicates.

IV. Discussion

This study aimed to evaluate the crude samples of spices and examine the potential growth inhibition effects of four cold and four hot extracts derived from four spices, utilising the volumetric zone of inhibition assay. Cold-extracted crude samples exhibited the highest levels of inhibition against the yeasts *Dekkera anomala*, *Dekkera bruxellensis*, *Z. microellipsoides*, *Z. rouxii*, *Z. fermentati* (2), *Z. cidrii*, and *Z. florentinus*. Djansang (*Ricinodendron heudelotii*) and 4 coté (*Tetrapleura tetraptera*) exhibited growth inhibition properties against yeasts, while Larbie [14] reported that these spices were capable of inhibiting bacteria. However, hot extracts of certain spices autoclaved at 120°C for 15 minutes lost their antimicrobial efficacy against various microorganisms, as the hot extracts of 4 coté (*Tetrapleura tetraptera*) failed to inhibit the growth of *Z. rouxii*, in contrast to the cold extracts, which demonstrated a broader inhibitory effect. A similar trend was noted with Djansang (*Ricinodendron heudelotii*), where hot crude extracts exhibited little growth inhibition. The spices Djansang (*Ricinodendron heudelotii*), Pebe (*Scorodophloeus zenkeri*), 4 coté (*Tetrapleura tetraptera*), and Country onion (*Afrostyrax lepidophyllus*), native to Cameroon, indicate a paucity of studies regarding their growth inhibition efficacy against yeasts.

This research aimed to assess the health-promoting potential of African indigenous spices by analysing the cooking processes of tomato sauce and Achu soup. It was found that tomato sauce heated to 70℃ and 100℃ exhibited a higher microbial count on PCA and WL than tomato sauce treated with potassium sorbate, a commonly used food preservative. The microbial counts for tomato sauce plated on PCA and WL were inconsistent, due to fluctuations in the counts, maybe attributable to sample heterogeneity before sampling or human error during the dilution procedure. The Achu soup exhibited an elevated microbial count across three distinct media during the initial trial. Further analysis revealed that the high microbial count was due to improper storage and handling of the ingredients, leading to bacterial growth in the soup. This highlighted the importance of maintaining proper food safety protocols to prevent contamination and ensure consumer safety.

The initial batch of Achu soup had a greater microbiological count when plated on PCA and WL, with contamination attributed to the blender, despite thorough cleaning and rinsing with SO2. No coliform contamination was detected from the blender, indicating that all coliforms originated from the Achu soup. The microbial count for Achu soup treated with potassium sorbate exhibited variable findings, potentially attributable to human error during sampling and dilution preparation. The second batch exhibited a reduced microbial count, as Achu soup was subjected to an additional cooking process in jars at 100°C in water for 20 minutes, thereby eliminating most bacteria present in the soup. In the second trial, Achu soup exhibited reduced microbial counts for PCA and WL, with no coliform organisms detected on VRBA, indicating that the soup was not produced using a blender, hence minimising contamination. These chemicals are mostly recognised for their antioxidant and anti-inflammatory properties.

Although quercetin was detected in elevated concentrations in the spice-mix tomato sauce samples, the efficacy of a component is not exclusively contingent upon its concentration but also on its absorption and utilisation by the body. Moreover, individual tolerance and reactions to certain chemicals can differ, complicating the establishment of a universal consumption level for best health benefits. For example, although the spice-mix tomato sauce samples may contain 6.5 mg/L of quercetin, an individual may not attain the complete health advantages if their body does not efficiently absorb and utilise the bioactive compound. Moreover, an individual with a greater tolerance for quercetin may necessitate a higher intake to attain equivalent benefits as one with a lesser tolerance.The higher concentrations of Catechin (9 mg/L) in the processed tomato sauce preserved with potassium sorbate was revealed in this study. Specific substances necessitate precise dietary levels to provide health advantages; for instance, 9 mg/L of catechin is essential. However, excessive use of catechin may result in adverse consequences, including gastrointestinal distress and headaches. Moderate consumption of catechin is essential to optimise its potential health benefits while minimising undesirable effects [15]. Additional research is required to ascertain the ideal dietary concentrations of catechin for comprehensive health and wellness.

Some chemicals require specific dietary quantities to provide health benefits; for example, 6.9 mg/L of quercetin is essential. However, excessive consumption of certain substances may adversely affect the body [16]. Consequently, it is essential to maintain a balanced diet and avoid dependence on a singular element for health advantages. Moderation is essential for maintaining overall well-being and preventing unpleasant reactions associated with any dietary component. Moreover, integrating a diverse array of nutrients-rich foods is crucial for attaining the best health possible. Vanillic acid, the distinctive ingredient in the spice mix for tomatoes, possesses antioxidant, anti-inflammatory, and neuroprotective health-promoting qualities [17]. The techniques employed in the preparation of tomato sauce and Achu soup yielded foods that are safe for consumption and include components with potential health advantages.

V. Conclusion

Djansang (*Ricinodendron heudelotii*), and 4 coté (*Tetrapleura tetraptera*) crude extract samples demonstrated antimicrobial potential against some spoilage yeast species. The results clearly indicate that cold crude extracted samples had better growth inhibition activity than hot crude extracted samples extraction. The volumetric zone of inhibition assay of Djansang (*Ricinodendron heudelotii*) extracts against microorganisms showed to have broader inhibition zones against 7 yeast species while Pebe (*Scorodophloeus zenkeri*) and Country onion (*Afrostyrax lepidophyllus*) showed no growth inhibition potential against the selected species**.** This study can be used as an important tool to acknowledge the positive effects of some spices to be considered as potential natural antimicrobial agents in the food industry. This study also demonstrated that indigenous African spices Djansang (*Ricinodendron heudelotii*), Pebe (*Scorodophloeus zenkeri*), 4 coté (*Tetrapleura tetraptera*), and Country onion (*Afrostyrax lepidophyllus*) through processed tomato sauce and Achu soup, do in fact contain compounds with health-promoting properties, antioxidant compounds such as vanillic acid, quercetin, and caftaric acid, epicatechin gallate, quercetin, and catechin, and anti-inflammatory properties (catechin, epicatechin gallate, and caftaric acid). According to the shelf-life study of tomato sauce, the sauces were safe for consumption for approximately 7-12 weeks. The shelf life of Achu soup showed that it was safe for consumption for more than 5 weeks when cooked at 100°C for 20 minutes and it was safe to consume for more than 4 weeks when prepared without external contamination. Future work in this area could involve further research into the specific health benefits of these compounds found in both tomato sauce and Achu soup. Additionally, exploring different cooking methods and temperatures could help determine the best way to preserve these health-promoting properties in the food products. Understanding how these compounds interact with each other during cooking and storage could also provide valuable insights for improving the shelf life and nutritional quality of these dishes.

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