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EFFICACY OF VEGETABLES TREATED WITH SUGARCANE VINEGAR ON GUT MICROBES

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ABSTRACT
The plant's antioxidant components, particularly the phenolic chemicals found mostly in the raw juice, culms, and leaves, have been linked to sugarcane's positive health effects. Nevertheless, not all of the research has been done on the existence of particular naturally occurring phenolic components in non-processed cane sugars and their possible effects on diet as a substitute for refined sugar. A naturally occurring result of fermentation is sugarcane vinegar. Foods high in carbohydrates are a great supply of the substrate needed to make vinegar. Because of its flavor and aroma, sugarcane vinegar is widely utilized as an ingredient in food preparation. One possible explanation for vinegar's medicinal effect is that it contains acetic acid together with other components. Using the agar well diffusion technique, the antimicrobial activity of the following foods treated with sugarcane vinegar was assessed: green chili (*Capsicum annum*), raw papaya (*Carica papaya*), white radish (*Raphanus sativus*), ginger (*Zingiber officinale*), garlic (*Allium sativum*), onion (*Allium cepa*), and raw papaya (*Carica papaya*). The foods were tested against a variety of gut microbes, including *Bifidobacterium dentium, Lactobacillus buchneri, Lactobacillus formosensia, Lactobacillus agilis,* and *Aerococcus suis.*

KEYWORDS: Sugarcane, Ginger, Gut microbes, Phenolic compounds, Vinegar, Antioxidant.

INTRODUCTION
The preparation of sugarcane vinegar involves extracting juice from ripe sugarcane stems, sterilizing them, and subjecting them to alcohol.[1,2] Sugarcane vinegar is a sweet and sour beverage made from sugar crops in particular. acetic acid[3,4] and other microbial fermentation processes. It is an advanced type of vinegar product.[5,8] In China, vinegar is a common acidic condiment that has gained popularity due to its many health advantages. According to studies by[9,12] Cejudo-Bastante *et al*. (2013), Budak *et al*. (2014), Cejudo-Bastante *et al*. (2016), Chen *et al*. (2016), it regulates high blood pressure, glucose, and lipid metabolism, acts as an antioxidant, antibacterial, anti-inflammatory, and anticancer agent, aids in the prevention of cardiac disorders, improves cognition, and encourages weight loss. It is produced by a two-step fermentation process from raw materials that are primarily composed of carbohydrates: first, ethanol is formed by yeasts (typically Saccharomyces spp.) through the conversion of fermentable sugars (alcoholic fermentation); second, ethanol is converted to acetic acid (acetic acid fermentation or acetification).[13,15] He *et al*.[16] found that beverages made with sugarcane vinegar included ten significant phenolic compounds: apigenin, coumarin, kaempferol, luteolin, vanillin, caffeic acid, chlorogenic acid, cinnamic acid, p-coumaric acid, ferulic acid, and apigenin. Numerous regions of the world have employed sugarcane to treat a variety of illnesses. As per Anis *et al*.[17] and Vedavthy et *al.[18]*, sugarcane is utilized as a medication in the Ayurvedic system, either alone or in conjunction with other plant ingredients. According to Kartikan *et al.[19]* and Caceres et al.[20], sugarcane juice has been suggested as a diuretic by certain indigenous and conventional healers. Drinking sugarcane juice regularly is supposed to maintain a rapid and clear flow of urine, which in turn supports healthy kidney function. For best benefits, it can also occasionally be used with ginger and lime juice. It is also used as an aphrodisiac, laxative, cooling, demulcent, antiseptic, and tonic.[21] It is considered beneficial for the liver and it is recommended that jaundice patients take in a large amount of sugarcane juice for immediate relief. The assumptions of these traditional Indian medicinal systems have been supported by modern pharmacological studies, which have indicated that sugarcane has various bioactivities like

anti‑inflammatory, analgesic, antihyperglycemic, diuretic, and hepatoprotective effects. As an herb, garlic has long been used as a spice in a variety of culinary preparations. Individuals are thought to benefit from the health benefits of garlic and its constituent parts. Numerous organosulfur compounds, including allicin, which can enhance digestion and promote development, are present in it.[22] The onion has long been valued for its medicinal qualities in addition to its culinary uses. Researchers have found that eating onions is good for your health because they are high in phytonutrients called polyphenols, which include flavonoids, tannins, and allicin, which have antibacterial and antioxidant qualities.[23] Both quercetin and allicin (thio-2-propene-1-sulfinic acid-5-allyl-esters), which are the primary antibacterial agents found in onions, bind to the bacterial DNA gyrase while inhibiting specific thiol-containing enzymes in microorganisms by the fast reaction of thio-sulfinates.[24]

The gut microbiota is a complex microbial community that interacts with one another and with the host organism, influencing many aspects of human health.[25,26] The majority of substances that are consumed, whether for nutritional, medicinal, or other reasons, affect the microbiota. On the other hand, the microbiota may also metabolize a wide range of drugs that are consumed orally.[27,28] Supplementing with ginger can alter the gut microbiota's composition, impacting obesity, insulin resistance, hepatic steatosis, and low-grade inflammation in mice.[29]

MATERIALS AND METHODS

Selection of vegetables: We select ginger (*Zingiber officinale*), garlic (*Allium sativum*), onion (*Allium cepa*), raw papaya (*Carica papaya)*, white radish (*Raphanus sativus*), and green chili (*Capsicum annuum*) for my research and were purchased from the local market in Bijnor, India (U.P.), cleaned to remove soil, peeled off, and washed again under running tap water in the research lab of Krishna Institute of Science and Information technology Bijnor (U.P). Each of these vegetables was dried at room temperature in the lab after being chopped into little pieces. Even if the vegetables have been peeled, drying the whole item will still take at least 24 to 48 hours. This procedure takes 1 to 2 days.

Extract Preparation: For extraction, we use sugarcane vinegar of Vigour of Village Natural Vinegar, Village Food Products, Saradhana, District: Meerut, they are prepared natural vinegar without using any preservatives and chemicals. After drying all eatables were put into the 25ml of sugarcane vinegar for 7 days (Fig.1). Thereafter, these were crushed with vinegar and filtered through normal filter paper. The extract was stored in a glass jar at room temperature for further use.

Qualitative Analysis: Using the AOAS methodology (1990), as defined by Singh and Garg[30] and Trease and Evans[31], qualitative standard chemical tests were conducted for a phytochemical screening of vegetables. These tests all detected alkaloids, saponins, tannins, flavonoids, anthraquinones, terpenoids, and glycosides.

Antimicrobial activity by agar well diffusion method: Using an agar well diffusion experiment, the antimicrobial activity spectra of five isolates were analyzed against the gut microorganisms *Aerococcus suis*, *Bifidobacterium dentium*, *Lactobacillus buchneri*, *Lactobacillus formosensia*, and *Lactobacillus agilis*. After swabbing 100µl of the pathogenic bacteria's 24-hour-old cultures from the nutrient broth onto Muller-Hinton agar (MHA) plates, a sterile cock borer was used to create the well. Twenty microliters of each extract's supernatant were added to wells, and the plates were then incubated for 24 to 48 hours at 37°C. The diameter of the inhibition zones and the mean diameter for the inhibition zone were calculated. The benefit of the well diffusion assay is that, instead of loading a disc, we can often put more samples into a well at once. The phytocompound's capacity to disperse over the agar is vital when applying the well diffusion method. A ruler, a set of calipers, or a template measure the zone of inhibition. Its measurements are stated in millimeters, usually rounded to the nearest millimeter. The diameter of the well is also given. Without using any instruments, these measurements are performed with the naked eye.

RESULT AND DISCUSSION

The primary goals of this study are the effects of particular gut microorganisms on particular vegetables and the examination of various phytochemical bioactive components in sugar cane vinegar. We have examined the many phytochemical components of sugarcane vinegar in this study, including protein, carbohydrates, flavonoids, alkaloids, saponins, glycosides, terpenoids, and anthraquinones (Table 1), all of which are highly advantageous to human health. Plants naturally contain compounds called phytochemicals, which are also referred to as phytonutrients. These compounds have antioxidant properties and are good for human health. Plant alkaloids are used as anesthetic agents in pharmaceutical products. According to this study, there are antibacterial components in food extract made with vinegar that could take the place of antibiotics. The results of this study confirm and advance our understanding of vinegar's potential benefits for food safety and health. Phytochemicals, sometimes referred to as phytonutrients, are naturally occurring compounds that are present in plants and are essential for the body's detoxification of toxic and detrimental chemicals. According to Nilgun *et al*.[32] organically fermented vinegar products have antioxidative, antidiabetic, antibacterial, anticancer, anti-obesity, antihypertensive, and cholesterol-lowering qualities. Alkaloids found in plants are employed as anesthetics in pharmaceutical products. Due to its high content of vital elements including calcium, phosphorus, manganese, zinc, and iron, as well as several amino acids such as aspartic acid, alanine, and citric acid, as well as vitamins A, B1, B2, B3, and C, niacin, and riboflavin, sugarcane juice is very good for human health.[33,34]

The antimicrobial activities of garlic, ginger, onion, raw papaya, white radish, and green chili against specific gut microbes *Lactobacillus agilis*, *Bifidobacterium dentium*, *Lactobacillus buchneri*, *Lactobacillus formosensia*, and *Aerococcus suis* were found to be higher after soaking for seven days in sugarcane vinegar, according to antimicrobial studies conducted using the agar well diffusion method. Based on this study, antimicrobial substances found in food extract made with vinegar have the potential to replace antibiotics. The results of this study add to our understanding of the possible health benefits and improvements that vinegar can bring about for food safety. The phytochemical bioactive elements of food items such as carbohydrates, protein, flavonoids, alkaloids, saponins, glycosides, terpenoids, and anthraquinones have been examined in this study using sugarcane vinegar (Table 1). According to this study, there are no alkaloids in sugarcane vinegar, but when various foods are treated with vinegar, alkaloids are present because of edible bioactive compounds. This implies that some bioactive compounds become active after seven days of being soaked in sugarcane vinegar. According to this study, there are antibacterial components in food extract made with vinegar that could take the place of antibiotics. The results of this study confirm and advance our understanding of vinegar's potential benefits for food safety and health.

The antibacterial properties of onions are widely recognized; however, when treated with sugarcane vinegar, the onion exhibits greater antimicrobial activity against *Shigella flexneri*, while untreated sugarcane vinegar exhibits reduced antimicrobial activity against *S. flexneri*. This study indicates that treating onions with sugarcane vinegar has a greater positive impact on human health. The nutritional value and antimicrobial activity of foods, both untreated and sugarcane-treated, are determined by the presence of medicinally active substances such as flavonoids, alkaloids, saponin, tannins, anthraquinones, terpenoids, and glycosides.[35] As mentioned in the publication (30), several foods are good for us; however, this study suggests that these foods are even better for us if treated with sugarcane vinegar. As indicated by Table 2's results, the maximum zone of inhibition against *Lactobacillus agilis* for the sugarcane vinegar extract containing ginger and onion was 9 mm, while the zone of inhibition against the same bacteria for the garlic extract was 8.8 mm. Regarding *Lactobacillus agilis*, white radish has demonstrated an 8.4 mm zone of inhibition and green chili has demonstrated an 8 mm zone of inhibition (Table 2; Fig. 2). (Table 2; Fig. 2) An 8.2 mm zone is present in raw papaya against this bacterium. An 8 mm zone of inhibition at *Bifidobacterium dentium* is observed in white radishes, while an 8 mm zone is found in raw papaya and garlic at the same bacteria, per the data analysis in Table 2. Table 2 shows that ginger inhibits *Bifidobacterium dentium* in a 7.5 mm zone. The available data indicates that garlic has a somewhat wider (9.2 mm) zone of inhibition against *Lactobacillus buchneri* than both white radish and green chili (Table 2; Fig. 2). Nevertheless, both have a 9 mm zone of inhibition against the same bacteria. Garlic has been shown to have the biggest zone of inhibition (10 mm) against both *Lactobacillus formosensia and Aerococcus suis*, while ginger and white radish each had a 10 mm zone against *Lactobacillus buchneri* and *Aerococcus suis*, respectively (Table 2; Fig. 2). Based on Table 2, we can see that the raw papaya and green chili have a 9.2 mm zone of inhibition against *Lactobacillus formosensia* and *Aerococcus suis*, whereas ginger and white radish both exhibit an 8 mm zone of inhibition against *Lactobacillus formosensia* (Table 2).

Fig. 1: Preparation of extraction of different vegetables with sugarcane vinegar.

Table 1: Qualitative analysis of vegetables treated and untreated with sugarcane vinegar.

Phytochemicals	Sugarcane vinegar	Eatables											
		Ginger		Garlic		Onion		Raw apaya		Green Chilli		White radish	
		WE	SCE	WE	SCE	WE	SCE	WE	SCE	WE	SCE	WE	SCE
Alkaloids	−	+	+	+	+	+	+	+	+	+	+	+	+
Saponins	+	+	+	+	+	+	+	+	+	−	+	+	+
Tannins	+	−	+	+	+	+	+	+	+	+	+	+	+
Flavonoids	+	+	+	+	+	+	+	+	+	+	+	+	+
Terpenoids	+	+	+	+	+	−	+	+	−	+	+	+	+
Glycosides	+	+	+	+	+	+	+	+	+	+	+	+	+
Anthraquinones	−	−	−	+	+	+	+	−	−	+	+	+	+
Carbohydrates	+	+	+	+	+	+	+	+	+	+	+	+	+
Phenolic compounds	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 2: Zone of inhibition of sugarcane vinegar extract with eatables after 24 hr. on gut microbiome pathogens.

Bacterial strains	Eatables						
	Control SCV (mm)	Garlic (mm)	Ginger (mm)	Onion (mm)	Raw papaya (mm)	White radish (mm)	Green chilli (mm)
Lactobacillus agilis	8	8.8	9	9	8.2	8.4	8
Bifidobacterium dentium	7	8	7.5	9	8	8.6	8.6
Lactobacillus buchneri	8	9.2	10	10	9.6	9	9
Lactobacillus formosensia	7	10	8	8.9	9.2	8	8.8
Aerococcus suis	8.2	10	9.8	10.6	9.4	10	9.2

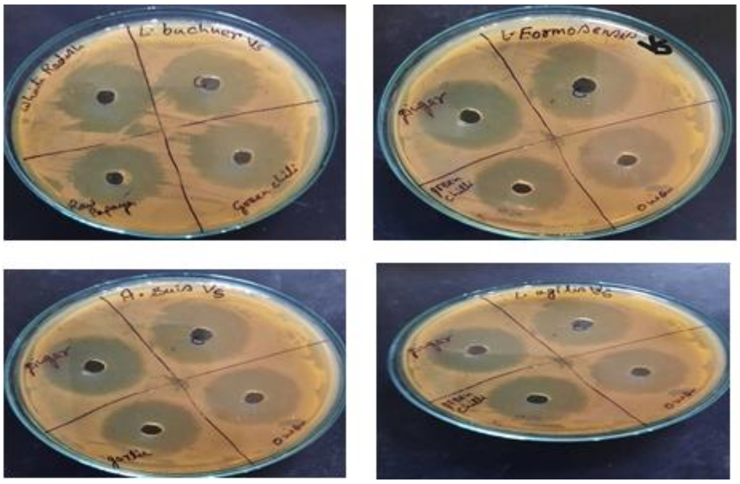

Fig. 2: Zone of inhibition of sugarcane vinegar extract of different eatables: ginger, garlic, raw papaya, and onion and C denoted as sugarcane vinegar control against *Lactobacillus buchneri* plate A; *Lactobacillus formosensia* plate B; *Aerococcus suis* plate C; and plate D *Lactobacillus agilis* respectively.

CONCLUSION

Our research indicates that sugarcane vinegar, a commercial surface disinfectant, is more effective against gut microbes and can be used to clean fruits and vegetables. There has also been a recent spike in demand for products manufactured with organic and gluten-free vinegar among consumers who place a high value on their health. There is a noticeable surge in demand for ready-to-eat food products due to factors like busy schedules, changing dietary preferences, and rising levels of disposable money. Because vinegar is natural and, on the GRAS, (Generally Recognised as Safe) list, it is a viable option for surface disinfection of fruits and vegetables at home due to its strong antibacterial activity. With its antibacterial properties, ability to lower blood pressure, antioxidant properties, ability to lessen the symptoms of diabetes, and ability to prevent cardiovascular disease, vinegar is incredibly beneficial to human health. My findings indicate that vinegar works better with food. Consuming vinegar daily has also been shown to improve blood glucose sensitivity, which is advantageous for diabetics. vinegar is one of the Ayurvedic herbs used in sugarcane. It is advantageous to keep blood sugar levels stable. The drink is filling and has a delicious flavor. Its positive effects extend to internal organs such as the heart, brain, kidneys, and intestines.

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