

A REVIEW ON PHARMACOLOGY AND PHYTOCHEMISTRY OF SUGARCANE RIND

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ABSTRACT

Sugarcane (*Saccharum officinarum* linn) is a vital perennial grass of Gramineae family, autochthonal to tropical south asia and geographic area. It's cultivated worldwide because of the economical Associate in Nursing medicinal worth of its high yielding products. Sugarcane rind is sometimes treated as an industrial waste. However, it contains valuable phytochemicals that may be extracted and utilised. Herein we offer a comprehensive review concerning application and health edges of the phytochemicals in sugarcane rind, together with polyphenols, flavonoids, particularly anthocynins, phenoplast acids, long chain fatty alcohols notably 1-octacosal, phytosterols and fiber. Numerous bioactivities area unit related to these phytochemicals, like inhibitor, anticancer, antiviral, inhibition of inflammatory and attenuation of the chance of vessel and coronary sickness. However, any studies area unit secured to target health edges of sugarcane rind and to elucidate their action mechanisms.

KEYWORDS: Sugarcane, Flavonoids, Sugarcane rind, Biological activity.**INTRODUCTION**

Saccharum officinarum, which is known as sugarcane in common terms is a indigenous crop to India and common in tropical and subtropical countries. It is known for its high content of sucrose in its stem. Therefore sugarcane is mostly used in sugar production.

The outer layer of sugarcane stem is also called as skin, peel, rind or epidermis among others. In sugar industry, sugarcane is usually squeezed to extract sucrose juice. In general to obtain high yields of sugar and to shorter the process time, the sugarcane is peeled by using abrasive tools. In this process the left over rind is considered as a waste material which is technically termed as 'bagasse'.

In the year of 2017 - 2018 the global sugar production was estimated to reach a new record of 185 million metric tons. Brazil, India, European union, Thailand and China are considered as the top five sugar producers in the year of 2017 – 2018. In general, 80% of the world's sugar production is done through sugarcane and the remaining 20% is done from the sugar beet and palm. It is estimated that 100 tons of sugarcane can roughly produce raw sugar of 14.3 tons filter cake of 5.2 tons, bagasse of 27.2 tons, molasses of 2.6 tons and waste water of 50.7 tons.^[1]

**Taxonomical Classification**

Kingdom: Plantae
Family: Poaceae
Order: Poales
Subfamily: Panicoideae
Tribe: Andropogoneae
Genus: *Saccharum*
Species: *S.officinarum*

Botanical Description

Sugar cane is a perennial plant, which consists of a number of well built unbranched stems. It grows in clumps. The stems vary in color. They may be pink, purple or green and can reach 5 cms(16 feet) in height. It consists of a network of rhizomes under the soil, which sends up secondary shoots near the parent plant. They are jointed through the nodes present at the bases of alternate leaves. The inter nodes contain a fibrous white

pith which is immersed in a sugary sap. The thick mid ribs and saw – toothed edges which are present in elongated, linear, green leaves grows to a length of 30 – 60 cms(12 – 24 ins) and width of 5 cms(2.0 ins). The terminal inflorescence is a panicle upto 60 cms(24 ins) long, a pinkish plume that is wider at the base and tapering towards the top. The spikelets are borne on side branches that are about 3 mm (0.12 ins) and are masked in tufts of long, silky hair. Each of the fruits which are dry contains a single seed.^[2] As the flowering process causes a reduction in sugar content, sugar cane harvesting is done before the flowering.^[3]

Method of Extraction

Initially, the peel of *Saccharum officinarum* is collected, cut into smaller pieces and then completely oven dried at 700 c. Then the dried peel is grounded to fine powder, mixed with 80% ethanol and soaked for three days. A clean muslin cloth is taken and the mixture is filtered. The filtrate is collected in a beaker and kept in the oven to evaporate the ethanol to yield 86.3 g of the extract. The concentration is dissolved in distilled water for the purpose of this study.^[4]

Chemical Constituents

Sugar cane rind consists of phytochemicals such as phenolic acids, flavanoids, phytosterols and others that

have not been investigated and utilized adequately for their potential values.

Recent studies notified that the phytochemicals which are present in the rind have significant health benefits which includes as antioxidant, anticancer, antitumor and antifibrotic properties. The beneficial effects of sugarcane peel ethanolic extract on hematological and histopathological parameters of Wistar extract lead to the decrease in the levels of white blood cells, packed cell volume, platelets and haemoglobin and also the increase in degeneration of follicles. The antifibrotic properties of *saccharum officinarum* poly phenol extract have been proven by prevention of p38 and JNK phosphorylation MAPK signaling pathways in CCl₄ induced liver fibrosis rats. These studies lead to the investigation in reusing sugarcane rind, underlying the actual profound values of rind both in nutrition and economy. In this review, we focus to provide a summary of composition and health advantages of phytochemicals in sugarcane rind, to draw more attention to its research and usage and phytosterols such as stigmasterol, campesterol and β – sitosterol can be extracted from sugarcane rind.^[5]

Chemical constituents	Bioactivity
Polyphenols	Antioxidants Anti-radical activity Anti-carcinogenic Anti-atherosclerotic Anti-inflammatory Anti- microbial Anti-hyperglycemic Spasmolytic Anti-viral Hepato protective Oestrogenic activity Inhibition of histamine release
Flavonoids	Anti-oxidant Anxiolytic and neuroprotective effects in an animal models Cholinergic neuro transmission regulation Stimulating insulin secretion Outstanding anti-hyperglycemic Anti-proliferative activity
Phenolic acids	Anti-oxidant Anti-inflammatory Anti-tumor Anti-histamine activities Anti tumor ability
Long chain fatty alcohols	Anti-inflammatory Anti-tumor
Phytosterols	Anti-inflammatory Anti-cancer and immuno modulatory properties
Fibers	Lowering the risk of ovarian cancer Coronary heart disease

Pharmacological Activity

1. Antibacterial activity of polyphenols

These are the group of natural products found in fruits, nuts, seeds, vegetables, stems and flowers. The compounds such as tannins and dietary flavonoids exerts antioxidant, anti-inflammatory, antibacterial effects. In the era of increasing antibiotic resistance, the development of new strategies to fight bacteria is welcome. To evaluate the therapeutic potential at polyphenols and to develop the combination with currently available antibiotics, further studies are conducted.^[6]

2. Anticancer activity of Polyphenols

Polyphenols are found abundantly in plants. They exhibit many anti carcinogenic properties including their inhibitory effects on cancer cell, tumor growth, proliferation metastasis, angiogenesis, inducing apoptosis and inflammation. They can also modulate immune system response and protect the normal cells against free radicals damages. Majorly the investigations on anticancer mechanisms of polyphenols were conducted with individual compounds. Several studies including ours indicated that the enhancement of the anticancer efficacy and scope of action can be done by combining them synergistically with chemically similar or different compounds. Most of the studies explore the anticancer effects of combinations of two or three compounds, we used more mixtures of specific polyphenols with vitamins, amino acids and other micro nutrients. The significant inhibition of growth of Fanconi anemia head and neck squamous cell carcinoma and dose dependent inhibition of cell proliferation, matrix metalloproteinase (MMP) -2 and -9 secretion, cell migration and invasion through Matrigel. PB was found effective in inhibition of fibro sarcoma HT – 1080 and melanoma A2058 cell proliferation, MMP-2 and – 9 expression, invasion through Matrigel and inducing apoptosis, important parameters for cancer prevention are done by using the mixture containing quercetin, curcumin, green tea, cruciferex and resveratrol(PB). A combination of polyphenols (quercetin and green tea extract) with vitamin C, amino acids and other micronutrients (EPQ) showed significant aupression of ovarian cancer ES – 2 xenograft tumor growth and suppression of ovarian tumor growth and lung metastasis. The enhancement of inhibitory effect of epigallocatechin gallate (EGCG) on secretion of MMPs is done due to the presence of vitamin C, amino acids and other micro nutrients. In addition enrichment of NM with quercetin (EPQ mix) increased anticancer activity of NM in vivo. in polyphenols, particularly in combination with other polyphenols, have been shown to be effective against multiple targets in cancer development and progression and should be considered as safe and effective approaches in cancer prevention and therapy.^[7]

3. Anti-inflammatory and Anti oxidant activities of Polyphenols

The anti inflammatory activity of the extracts wasted in LPS – stimulated macrophages though the DPPH radical scavenging activity, the SOD – like activity, the reducing power and the inhibition of lipid preoxidation. The inhibition of albumin denaturaton and protienase inhibitory action tests helped in the evaluation of anti inflammatory activity. The total polyphenols, flavanoids and tannins content were qualified.

Both the extracts were able to reduce the augmented no release in LPS-activated macro phases and showed antioxidant and invitro anti-inflammatory activities. When compared to the polyphenols content obtained in misiones the polyphenols content was higher in the extract obtained from the specimen from salta. This accounts for the anti-inflammatory and antioxidant properties obtained with the former.

The differences in the chemical composition and the biological activities observed between the extracts are probably related to the different environmental conditions found in both provinces.^[8]

4. Anti-atherosclerosis activity of Polyphenols

A perfect health and life can be maintained by good nutrition. In daily life polyphenols are some common nutrients which are derived from fruits, vegetables, beverages and traditional medicinal herbs. They are potential substances against oxidative related diseases like cardiovascular disease specifically atherosclerosis-related ischemic heart disease and stroke. In this study, we noticed the risk factors for atherosclerosis, such as hypertension, diabetes mellitus, hyperlipidemia, obesity. The antioxidative and antiinflammation effects are exhibited by the strong radical scavenging properties of polyphenols. Polyphenols reduce ROS production by inhibiting oxidases and improving mitochondrial oxidative stress. It also inhibits the development of hypertension, diabetes mellitus, hyperlipidemia and obesity.^[9]

5. Antihyperglycemic activity of polyphenolic components:

The rat intestinal D-glucosidases, human salivary D-amylase activity and postprandial hyperglycemia in rats were tested by the evect of black/bitter cumin *Centratherum anthelminticum* (L.) Kuntze extract containing mixture of polyphenolic compounds. IC₅₀ values for rat intestinal sucrose is 34.1 § 3.8, maltase is 62.2 § 4.5 and p-nitrophenyl D-D-glucopyranoside (PNP-glycoside) is 500.5 § 11.9 µg. the human salivary D-amylase activity was also inhibited with IC₅₀ value of 185.5 § 4.9 µg. The inhibitory evect of CA was found to be 8-32 fold more potent than DL-catechin but less evective than acarbose on rat intestinal disaccharides and salivary D-amylase. The K₁ values of maltase, sucrose and PNP-glycoside hydrolysis activities inhibition were 30.24 µg, 76.67 µg and 341.60 µg respectively and found to be low in enzyme kinetic studies. The in vitro inhibition of glucosidases was

furtger conwermed by in vivo maltose tolerance test in rats.

Feeding of CA at 50 – 200mg/kg body weight (b.wt) to maltose(2.0 g/Kg b.wt),loaded rats significantly reduced the post prandial plasma glucose levels compared with agar base.the inhibitory components of CA were identified as a mixture of polyphenolic compounds viz., gallic acid,proto – catechuic acid ,caveic acid,ellagic acid,ferulic acid,quer – cetin acid and kaempferol. This study demonstrated that CA exerts anti hyperglycemic activity and thus may be useful for the management of diabetes mellitus.^[10]

6. Antioxidative and anti-histamine-release activities: The dried powder of bark of Excoecaria L (Euphorbiaceae), hexane, chloroform(Chl), ethyl acetate(EtA), ethanol(Eth), and water(DW) fractions were used in the study of the respective products' polyphenol content, antioxidative and anti-histamine release activities. Amongst all the components DW had the highest total polyphenol content, 348 mg gallic acid equivalent (GAE)/g followed by Eth(160.5 mg GAE/g). It was found that DW and Eth had high antioxidative and anti-histamine release activities compare to other fractions when DPPH free radical scavenging, reducing power, measurement of total antioxidant activity and ionophore A23187- induced histamine-release assays were used on them. Thin layer chromatography(TLC) revealed that Eth and Chl are found to consist of ellagic acid-like and lupeol-like compounds in them. Lupeol and ellagic acid testing standards at 100 µg/ml showed that lupeol had a little inhibitory effect on histamine release(24.5%) whereas ellagic acid showed no effect at all.^[11]

7. Antispasmodic activity of phenolic compounds

Black mulberry is an ancient traditional medicine. Various bioactivities including antimicrobial. Hypotensive, analgesic etc., effects have been reported to be exerted from its extract and constituents. In folk medicine, blackberry preparations are also used as antispasmodic agents but there are no related studies are available on its isolated constituents. Seven phenolic compounds were isolated from the methanol extract of *Morus nigra* when they were made to go through an extensive chromatographic purification. The compounds are.

- 1) Morusin
- 2) Kuwanon U
- 3) Kuwanon E
- 4) Moracin P
- 5) Moracin O
- 6) Albanol A
- 7) Albanol B

Related literature errors that are confusing the identity of moracin derivatives are clarified and a complete NMR signal assignment of moracin P and O was hereby achieved. The ileal and tracheal smooth muscle

contractions were inhibited by Moracin O with E_{max} values of 85% and 302 mg .Those actions were superior as compared with papaverine. It is demonstrated in our findings that there are some valuable antispasmodic agents from *Morus nigra* such as prenylated arylbenzourans, geranylated flavonoids and Diels-Alder adducts. For quality control of antispasmodic mulberry preparations, compounds 2,5 and 7 are suggested as marker compounds. Moracin O is a new lead compound for related drug development initiatives.^[12]

8. Antiviral properties of the natural polyphenols

WNV, ZIKV, DENV are form in Flavivirus are enveloped plus-strand RNA viruses transmitted by mosquitoes and constitute a threat to human health. There are no licensed drugs against them available currently, thus, it is necessary to search for effective antiviral molecules. It is better for a novel antiviral approach(economical, simple to use, and environmental friendly) that is the use of natural compounds. Moreover, a direct effect on WNV particles is showed by D and EGCG exerting a virucidal effect. We showed prevention of viral production of WNV variants that on acidic Ph requirements for viral fusion, indicating that their antiviral activity. Both compounds reduced the infectivity of ZIKV and DENV.^[13]

9. Antioxidative action, bioavailability and anticarcinogenic effects of Polyphenols

Polyphenols being secondary plant metabolic represent a large and diverse group of substances abundantly present in a wide range of fruits, herbs and vegetables. The current contribution is mainly focused on their bioavailability, antioxidative and anticarcinogenic properties. A promising eco-friendly alternative providing exceptional separation and protection from degradation of unstable polyphenols is highlighted with supercritical fluid extraction and an overview of extract methods is also given. Polyphenols as anticancer agents show some advantages such as omnipresence, specificity of the response and the absence of or low toxicity. Low bioavailability and rapid metabolism are the main problems represented. Nanoformulation of polyphenols is one of the promising solutions that prevents their degradation and thus enables significantly higher concentrations to reach the target cells. The use of mixtures of various polyphenols is another more practiced solution that bring synergistic effects, resulting in lowering of the required therapeutic dose and in multitargeted action. Their toxicity is reduced significantly by the combination of polyphenols with existing drugs and therapies.^[14]

10. The modulation of estrogen receptors(ERs) signaling

The regulation of cell and tissue redox balance are impacted by the dietary polyphenols when they have been ascribed to their direct antioxidant activity. Their effects could not be easily explained by the antioxidant action because of the relative poor bioavailability of

many of these compounds which may occur only at high circulating and tissue concentrations. Therefore, many efforts are taken to clarify the molecular mechanisms and the biological effect of polyphenols in both i.e. physiological and pathological conditions. The overall impact of these compounds on cancer risk and progression may be defined by polyphenols bioavailability, metabolism, and their effects on enzyme, membrane, and nuclear receptors and intracellular transduction mechanisms and it is still debated and not yet clarified. The biological effects in human cells can be induced since polyphenols are able to bind to estrogen receptor α (ER α) and β (ER β) through mimicking or inhibiting the action of endogenous estrogens, even at low concentrations.^[15]

11. Role of natural phenolics in hepatoprotection:

The liver is not only involved in metabolism and detoxification, but also participate in innate immune function and thus exposed to frequent target, thus, they are the frequent target of physical injury. Irrespective of the most acute, non-iterative situation, liver has the unique ability to regenerate and completely recoup. However, the regenerative capacity eventually becomes dysfunctional due to multiple conditions, including viral hepatitis, non-alcoholic fatty liver disease, long term alcohol abuse and chronic use of medications resulting in hepatic scarring and cirrhosis. Despite the recent therapeutic advances development of modern medicine, hepatic diseases. Present day, with number of synthetic and plant based drugs various hepatic problems are countered. Nexavar is a chemotherapeutic medication used to treat advanced renal cell carcinoma.^[16]

12. Anticancer activity

MTT assay performed the invitro antiproliferative activity of crude extract from sugarcane peel. The crude extract of exhibited 51.2 the cell line inhibition concentration is 0.625 μ g/ml, of the 9 different concentrations of crude extract, the peak concentration displayed peak inhibition displayed a dose dependent antiproliferative activity on HT29 cell line. Untreated HT29 cell line elongated shape, attached smoothly on the cell surface and some of the cells grouped together to form colonies.^[17]

CONCLUSION

Sugarcane rind has valuable phytochemicals together with numerous flavonoids, octacosanol, phenoplast acids, phytosterols and dietary fiber. These elements will offer important health edges like inhibitor, medicinal drug, anticancer, antiviral and any attenuation of the chance of vessel and coronary heart condition. As a disposed half in sugarcane trade, effective extraction of these phytochemicals from sugarcane rind is a double – win strategy. However, optimum extraction technique of every phytochemical entire extraction methods of many or all phytochemical still desire to be investigated. What is more, comparatively few analysis has centered on health edges of sugarcane rind and any studies area unit

needed to verify the particular mechanism behind associated health edges.

REFERENCES

1. Luo Y., S., and Ho, C. -T. (2018). Sugarcane rind : applications and health benefits: a review. *J. Food Bioact*, 3: 1-7.
2. Kew:Royal Botanic Gardens; 2012.Saccharum officinarum, 9-21. [Google Scholar]
3. Australian Government, Department of Health and Ageing, Office of the Gene Technology Regulator;2004.The Biology and Ecology of Sugarcane (Saccharum spp. hybrids) in Australia; p. 10. [Google Scholar]
4. ASHADE, O. O., 2ABUBAKAR, R. O., 2NGUKA, O. O., 2YAKUBU, A.O., 2OYESANYA, O., 2OFOEGBU, C. C., 2BELLO, O. N., 2OSUNTADE, B. A., July - Sep, 2014, Impact of Sugarcane peel (Saccharum officinarum) Extract on the Blood Status and Gonadal Integrity of Wistar Albino Rat, *IJAPBC*, 3(3): 1-10.
5. Luo Y., S., and Ho, C. -T. (2018). Sugarcane rind : applications and health benefits: a review. *J. Food Bioact*, 3 1-7.
6. Erika Coppo* and Anna Marchese, 2014, Antibacterial Activity of Polyphenols Microbiology Unit -DISC, University of Genoa, Italy, *Current Pharmaceutical Biotechnology*, 1-12.
7. Reference; Aleksandra Niedzwiecki*, Mohd Waheed Roomi, Tatiana Kalinovsky and Matthias Rath September 2016, Anticancer Efficacy of Polyphenols and their Combinations nutrients, 1-17.
8. Carla Marrassini*, Ignacio Peralta and Claudia Anesini, 2018, Comparative study of the Polyphenol content - related anti-inflammatory and antioxidant activities of two *Urea aurantiaca* specimens from different geographical areas, *chin med*, 1-12.
9. Yu-Chen Cheng, Jer-Ming Sheen, Wen Long Hu, and Yu-Ching Hung, 2017, Polyphenols and oxidative stress in Atherosclerosis-Related Ischemic Heart Disease and Stroke, *Hindawi*, 1-16.
10. V. Ani. K. Akhileder Naidu,2007, Antihyperglycemic activity of Polyphenolic compartments of black/bitter cumin *Centratherum anthelminticum* (L.) Kuntze seeds, *Springer -Verlag 2007 Eur Food Res Technol*, 1-8.
11. Hossain et al. 2009, ANTIOXIDATIVE AND ANTI-HISTAMINE -RELEASE ACTIVITIES OF EXCOECARIA AGALLOCHA L., *Pharmacologyonline*, 2009; 2: 927-936, 1-11
12. Zoofishan Zoofishan, Norbert Kúsz, Attila Csorba, Gabor Tóth, Judit Hajagos-Tóth Anna Kothencz, Róbert Gáspár and Attila Hunyadi* 2019, Antipasmotic Activity of Prenylated Phenolic Compounds from the Root Bark of *Moruz nigra*, *molecules*, 1-12.
13. Angela Vázquez-Calvo Nereida Jiménez de Oya, Niguel A. Martín-Acebes Emilia Garcia-Moruno and Juan - Carlos Said, 2017, Antiviral Properties of the Natural Polyphenols Delphinidin and

- Epigallocatechin Gallate against the Flaviviruses West Nile Virus, Zika Virus and Dengue Virus, *Frontiers in Microbiology*, 1-8.
14. Eva Brglez Mojzer †, Masa Knez Hrncić †, Mojca Skerget, Zeljko Knez, and Urban Bren, 2016, Polyphenols: Extraction Methods, Antioxidative Action, Bioavailability and Anticarcinogenic Effects, *molecules*, 1-38.
 15. Manuela Cipolletti, Virginia Solar Fernandez, Emiliano Montalesi, Maria Marino* and Macro Fiocchetti, 2018, Beyond the Antioxidant Activity of Dietary Polyphenols in Cancer : the Modulation of Estrogen Receptors (ERs) Signaling, *Int. J. Mol. Sci*, 2018; 1-23.
 16. Priyanka Saha Anupam Das Talukdar, Rajat Nath, Satyajit D. Sarker, Lutfun Nahar, Jagajit and Manabendra Dutta Chowdhury, 2019, Role of Natural phenolics in hepatoprotection: A Mechanistic Review and analysis of regulatory Network of Associated Genes, *Frontiers in Pharmacology*, 1-2.
 17. R. Pallavi², S. Elakkiya², Sai siva ram Tennety² and p. Suganya Devi 2012, Anthocyanin analysis and its Anticancer Property from Sugarcane (*Saccharum Officinarum* L) Peel, *INTERNATIONAL JOURNAL OF RESEARCH IN PHARMACY AND CHEMISTRY* , pg. ;1-8