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An investigation into the anticancer properties of black tea using in vivo model

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ABSTRACT

A Study of Black Tea's Anticancer Properties Using an In Vivo Model. Black tea contains compounds such as polyphenols, theaflavins, caffeine, L-theanine, and EGCG, which have been linked to potential anticancer properties. These compounds have been shown to prevent the growing of cancer cell and encourage involuntary cell death in laboratory studies. However, more study is required to conclude the exact anticancer properties of black tea in humans. Black tea's anti-carcinogenic qualities stem from its ability to regulate oxidative damage to endogenous antioxidants, mutagens, and biomolecules' antioxidant gene transcription pathways, among other things. Nonetheless, adding black tea to a healthy diet may have overall health benefits. Regular use of black tea, which is high in phytochemicals and may help prevent and treat cancer, has been connected regulation of several molecular targets, including 5-Lipoxygenase, Cyclooxygenase-2, c-Jun N-terminal Kinase, Signal Transducer and Activator of Transcription, Activator Protein 1, and MAPK. Black tea's anti-cancer action is supported in vivo; nevertheless, its impact on human trials is unknown, even if further clinical investigations at the molecular level are required to comprehend this feature.

Keywords: black tea, anticancer, properties, catechins, theaflavins

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INTRODUCTION

Black tea is a popular beverage, like its less-oxidized cousins, white, green, and oolong teas. It is produced from *Camellia sinensis* leaves and is consumed widely worldwide [1]. Black tea has been linked to a number of possible health advantages, including anticancer effects, in recent studies [2]. The polyphenolic chemicals found in tea possess of antioxidant, may aid in the prevention of cancer, in addition to offering defends against inflammatory, metabolic, and cardiovascular illnesses [3]. Given that black tea comprises 78% of the world market for tea beverages, we concentrated our research on the chemical and biological characteristics of black tea [4]. According to a chemical investigation, black tea also includes significant levels of Theaflavins and Catechins found in green tea. As a result, both Catechins and Theaflavins have additive or synergistic actions that increase the bioactivity of black tea [5]. Many investigations have assessed black tea's general bioactivity, while several a few studies, meanwhile, have connected the chemical profiles of black tea with its bioactivity data [6]. Theaflavins (TFs), the primary identification identifier of black tea, were enumerated together with their separate bioactivities in this review, along with a summary of the health benefits of black tea [7, 8]. Figure 1 and table 1 show the chemical structure of Theaflavins and figure 2 and table 2 depicts the chemical structure of Catechins.

Theaflavins (TFs) are produced when catechins undergo oxidative polymerization and condensation and Thearubigins (TRs) take occur as a result of the activity of Polyphenols Oxidase (PPO) and Peroxidase (PO) Macerating green tea leaves mechanically. Maceration is the process by which green tea leaves are broken up into smaller pieces [9]. There is a possibility that the chemical entities known as TFs and TRs are answerable not only for the color of the brew made from black tea, many health benefits. In this paper, we analyze the anticancer properties of black tea using in vivo model.

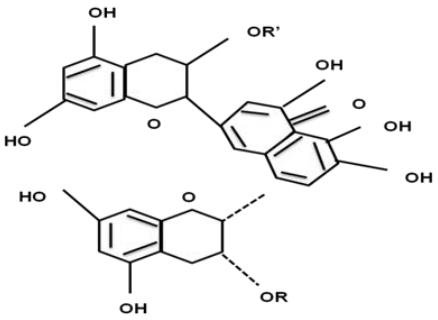

Fig. 1. Model of TF

Tab. 1. Theaflavins' molecular structure in chemistry

Compound	R'	R
Digallate (TF3)	Galloyl	Galloyl
TF (TF1)	H	H
TF-3- (TF2a)	H	Galloyl
TF-3' (TF2b)	Galloyl	H

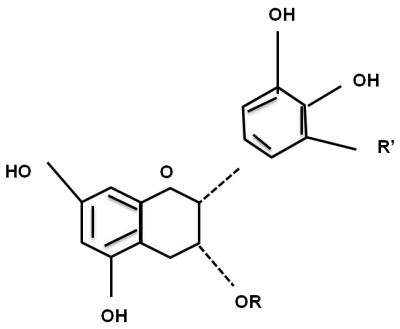

Fig. 2. Catechin structure

Tab. 2. Catechins' molecular structure in chemistry

Compound	R	R'
Epigallocatechin (EGC)	Galloyl	H
Epigallocatechin Gallate (EGCG)	H	OH
Epicatechin Gallate (ECG)	Galloyl	OH
Epicatechin (EC)	H	H

Research described to assess influence of the geometry of vessels by comparing the dynamics and bioactive characteristics of fermentation products produced in two vessels with differing surface ratios but identical volume ratios [10]. Article analyzed about the anti-cancer properties of TF in several Animal models of cancer and cultured cells in vivo [11]. The research also indicated that taking theasinens in by absorption of carbohydrates results in reduced intestinal fat absorption and glucose availability. Paper examined innovative bladder cancer therapy approaches based on green tea intake; effects of GTPs have also been demonstrated in studies using both in vivo animal models and in vitro bladder cancer cell lines [12]. When it comes to green tea-based therapy for these patients, they discuss the future prospects of black tea as an anti-bladder cancer agent. Based on the gathered data and the key results. Article summarized recent research on TRs' bio functions, including their impact on gastrointestinal motility, skeletal health, and mitochondrial activation, as well as their ant oxidation, ant mutagenic, and anticancer properties [13]. It also discussed some potential future research directions for TRs. Paper presented that the TFs may have beneficial impacts on human health as natural antioxidant substitutes and anticancer agents [14]. As a result, we anticipated that our research will offer useful insights into the development of therapeutic natural commodities. Paper represented the physical and chemical characteristics, purification separation techniques, bio-production processes of Theaflavins; next, to examine Theaflavins' examine the structure-activity connection of their antioxidant and anticancer activities; finally, they conclude Theaflavins' potential therapeutic applications [15]. The goal of the work was to mimic the process of drinking tea to extract antioxidants from teas [16]. Article evaluated the literature on the inhibitory properties of green tea different tumor genesis and angiogenesis, to mechanisms through which tea Catechins mediate cancer prevention in a range of cancer types [17]. Article provided the most recent findings examines the molecular mechanisms of action of green tea extracts against prostate cancer, including their impact on the growth of tumors, cell cycle, apoptosis, androgen receptor signaling, among other malignant processes, with a focus on their use in prevention and therapy [18]. Paper examined the molecular characteristics of CGA activities based on the results of animal are presented in the study [19]. The work's objective was to create and present a novel thin-film hydrated liposomal formulation of GTE that is stable in plasma and pH-sensitive. Poly Ethylene Glycol (PEG) was used to combine pH sensitivity and plasma stability features into a single delivery device. Instead of cholesterol hemi succinate was added to provide pH-sensitive properties [20]. Paper employed in vitro cell models to examine

the ant oxidative [21]. Treatment of green tea extract with tannase and cellulase yielded fractions was high. Article discussed the characteristics that restrict Catechins' oral bioavailability, the molecular processes by which Catechins exert their anticancer effects, and the most recent developments in administering Catechins via nano-delivery systems through various pathways to boost their anticancer effectiveness [22]. Study suggested that nanoscale CD-MOF-based porous materials are safe and non-toxic, showing tremendous potential in the area of Catechin stabilization for biological applications [23]. Article discussed the potential of EGCG and the need for additional research in this area by focusing on its impacts, antioxidant, antifibrosis properties [24]. Study's primary goal was to evaluate the differences between green tea extracts produced using six distinct systemic solvents, quick solvent extraction, ultrasonic extraction, and basic maceration, and to compare these extracts' polyphenols content and antioxidant activity [25].

MATERIALS AND METHODS

Cancer is the leading killer of humans anywhere in the globe. Due to their ability to generate internal indicators of expansion and reject host defines signals that inhibit growth, cancer cells have an infinite capacity for proliferation. It is also promoting angiogenesis, which can facilitate tumour invasion and dissemination. Natural products were successful in lowering cancer risk because they targeted the control of critical molecules and cellular signalling pathways in tumour development. Many researchers have shown to be beneficial, black tea may inhibit tumour growth and protect against cancer. The cancer chemo preventive benefit of black tea, for example, has been confirmed in research including ovarian cancer, rectal cancer, and prostate cancer. However, studies with an undefined quantity of intake of bioactive tea polyphenols may have produced varying results because of variances in real dose. Women who drank black tea daily had lower levels of 17-estradiol (E2), a hormone that is linked to an increased risk of cancer (Table 3). Female participants who regularly consume black tea had a lower chance of developing ovarian and bladder cancers. Black tea and the molecular mechanisms of polyphenols have also been the focus of several research groups. Treatment with 7-day black tea lowered lipid peroxidation and activated detoxifying enzymes in mice. 12-Dimethylbenz[a]Anthracene (DMBA) has fewer and smaller cutaneous papilloma's. Black tea's ability to counteract chemical carcinogenesis is tied in part to its ability to stimulate the production of detoxifying enzymes. The influence that carcinogens have on carcinogenesis is in large part determined by the detoxifying enzyme system.

The antioxidant EGCG and other components of black tea stimulate Nrf2 and increase the production of protective enzymes. The polyphenols in black tea have anti-carcinogenic properties, and they do so in several ways. One of these ways is via activating the transcription factor Nrf2.

Table 1 presents the molecular structures of the four primary theaflavins present in black tea, namely theaflavin-3, 3-O, Odigallate (TF3), Theaflavin-3-O-gallate (TF2b), Theaflavin-3-O-gallate (TF2a), Theaflavins (TF1), inhibiting Akt and NF-B activation and inducing ROS production, in HeLa cervical cancer cells, up-regulating cyclin D1, TFs induced apoptosis. Individual TFs have their activity against cancer cells, and these activities may or may not be synergistic with those of other TFs. In a human melanoma cell line, TF1 suppressed MMP-2 enzyme activity and gene/protein expression through the processes of Extracellular Regulated Protein Kinase (ERK), Nuclear Factor (NF)-B, and Epidermal Growth Factor Receptor (EGFR). Tumour suppressor gene p53 is commonly mutated or inactivated in breast cancer cells, which leads to resistance to chemotherapy. Treatment with TF2 decreased COX-2 gene expression, caused apoptosis, and suppressed cell proliferation in SV40-transformed WI38 human cells (WI38VA). TF2 had the most growth-inhibitory effect among the theaflavins on human histolytic lymphoma U937 cells, with TF3 demonstrating comparable potency in terms of anticancer and chemo preventive effects. It functioned as a catalyst for oxidative stress, which killed human oral squamous HSC-2 cells, and it inhibited the production of EGFR produced by EGF by causing protein breakdown and endocytosis the polyphenolic ingredients in black tea combine to combat cancer in several ways.

Tab. 3. Anti-cancer and anti-tumour properties have been observed in black tea and its bioactive components effects

	Molecular Mechanism
TF1	Reductions in MMP-2 expression and activity through nuclear factor (NF)-B signaling blocked the Akt/pAkt signaling pathway and activated the caspase-8/Fas death receptor pathway, which in turn caused apoptosis. Human breast cancer cells that lack the p53 survival pathway in breast cancer cells MCF-7, there was a downregulation of the fatty acid synthase (FAS) gene and protein expression. A growth and carcinogenesis in bronchiolar cells treated with 4-(methylnitrosamino) ethaneamine. A/J mice exposed to 1-butanone (NNK) developed lung cancer after consuming -1-(3-pyridyl) Cell growth is suppressed when proteasome activity is reduced
TF2	A human colon cancer cell line was made to undergo apoptosis, and mice's TPA-induced ear edema was inhibited. The capacity of cancer cells to proliferate, the triggering of apoptosis, In WI38VA and HeLa cells, p53 and Bax expression were increased to cause apoptosis. U937 cells are made to undergo apoptosis via a cascade driven by cytochrome c
TF3	Gene expression was suppressed by EGFR protein degradation and endocytosis. Elevated oxidative stress finally resulted in the demise of human oral squamous cells
Catechins	Cell proliferation was blocked by downregulating phosphorylated epidermal growth factor receptor and platelet-derived growth factor (PDGF) Endocytosis and degradation of EGFR proteins repressed gene expression Human oral squamous cells were subjected to elevated oxidative stress, which ultimately led to their death Human lung cancer cells were subjected to an ascorbic acid-induced cell cycle arrest
Black tea	Tea polyphenols cause tumors on the skin of mice to die off through the mitochondrial cell death pathway. Mammary tumors by inhibiting their progression via the downregulation of cyclooxygenase-2 (COX-2), nuclear factor-B (NF-B), and Akt

Black tea extract	Prevented DMBA-induced tumors in a hamster model of buccal pouch carcinogenesis by inter-fering with the action of enzyme that metabolize carcinogens

Efficacy as an antioxidant

Several diseases, including cardiovascular disease, cancer, inflammatory injury, atherosclerosis, senescence, and neurological disorders, may be traced back to oxidative damage to biomolecules brought on by an excess generation of FRS The significance of dietary decisions for human health has gained attention recently. Numerous epidemiological studies have found a correlation between a lower risk of cancer and increased consumption of plant-based foods such fruits, vegetables, spices, and medicinal herbs. Many plants include antioxidants like flavonoids and phenolic acids. By providing an activating antioxidant enzyme, chelating metal catalysts, a hydrogen atom or an electron, and blocking oxidases, these compounds, therefore limiting their entrance to cells. In recent decades, there has been a tremendous. Conversely, flavonoids are becoming more important as natural antioxidants due to the multitude of biological processes they participate in, which lowers the risk of several cancers. Black tea's anti-radical action comes from its bioactive components. This means that drinking tea activates your body's supply of antioxidant genes, hence lowering your chance of developing cancer. Black tea's high antioxidant activity is attributed to polyphenols such TFs, TRs, and gallic acid, among others. The polyphenols in black tea have been shown to prevent oxidative damage to cells caused by free radicals (Figure 3). Researchers found that steatosis liver had higher levels of oxidative stress, inflammation, and hepatocyte death than normal liver. However, TF1 treatment was shown to dramatically reduce the magnitude of these alterations.

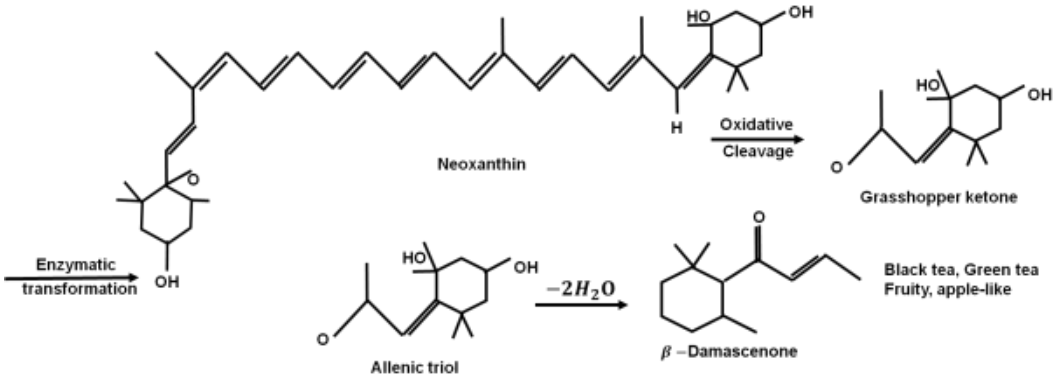

Fig. 3. Tea's volatile flavour compounds

The Free Radical (FR) scavenging actions of black tea are comparable to those of green tea, according to several studies. There is at least as much antioxidant potential in the TFs and TRs found in black tea as there is in the Catechins found in green tea. Atherogenesis is linked to lipoprotein oxidation damage. Black tea's flavonoids helped prevent atherosclerosis by blocking the oxidation of lipids. The incidence of LPO in the liver caused by Chlorpyrifos and Cypermethrin was reduced in mice when they were pretreated with black tea. CAT, SOD, GPx, GR, GSH, GST, and total thiol were all upregulated in conjunction with this protective effect. These enzyme-like proteins effectively reduce cellular damage caused by free radicals. According to the results of this research, black tea may aid in the restoration of the body's natural antioxidant defences. The Catechins in black tea, known as polyphenols, are the primary activity-modifying components. It has been shown via research that some TFs in black tea, including exhibit potent antioxidant action, TF-3, and TF-4, much like EGCG in green tea. In this way, these TFs suppress inflammation, cladogenesis, and various malignancies. Interestingly, it was revealed that EGCG alone had a significant impact on Jarkut cells with LPO, but when combined with black tea extract, there were no curative effects. The authors suggested that the reduction of EGCG's antioxidant action may have been caused by some components of black tea. Black tea extracts, at a concentration of 5 mg/mL, protected normal lymphocytes against radiation. Erythrocyte membrane skeletons and microsomes were protected against LPO by TFs. The galloyl moiety of TFs was scavenged by FRs, which led to an antioxidant action. Consumption of alcoholic beverages depletes the antioxidant system by causing oxidative stress due to the production of reactive oxygen species in the cells. Researchers discovered that TFs provided substantial protection preventing oxidative damage brought on by alcohol and provided some safety for cells in the brain. Mice livers were tested for their maximal antioxidant capacity. An analysis of the radioprotection that hot water extract of black tea afforded to DNA (Figure 4) shed light on the beverage's potential as an antioxidant. The calf thymus and pBR322 DNA showed the greatest levels of resistance. The IC50 for both was 182 mg/mL. 2-deoxyguanosine-8-hydroxy is a biochemical or radiological exposure indicator that is produced by oxidative DNA damage and detected in the plasma or urine. Factors involved in transcription were identified in rat liver epithelial RL-34 cells, where they were shown to reduce Mutagenesis and DNA damage by increasing antioxidant action and decreasing cytochrome P450 1A1. There was a clear hierarchy in the protective effects of polyphenols: TF4 > TF3 > TF2. The antioxidant activity of phenol-rich drinks was compared by Serafini and colleagues. These beverages included black tea, red wine, white wine, and green tea. An in vitro test employing Low-Density Lipoprotein (LDL) oxidation assay revealed that red wine has a greater antioxidant capacity than tea. The following sequence of reports was given for antioxidant capacity and phenolic content; forget about white wine and get straight to red. Surprisingly, black tea outperformed both green tea and red wine in terms of antioxidant activity when tested in an in vivo model. This happened because digestion and absorption alter the structure of polyphenols. This perspective was corroborated by some research on humans. Tables 4 and 5 show the molecular formula and molecular weight of black tea.

Tab. 4. The molecular structure of black tea's chemical components

Chemical Constituents	Color of Brew	Taste		Black Tea	Molecular Formula
		Taste Threshold Level (mol/L)			
Bifluranol A	-	Astringent and bitter	-	Small amount	$C_{44}H_{34}O_{22}$
	-	-	-	Trace	-
Thearubigin-3 (TR3)	-	-	-		-
Thearubigin-2 (TR2)	-	-	-		-
Thearubigin-1 (TR1)	-	-	Ashy and slight astringent	Trace	-
Thearubigins (TRs)	Reddish brown	-	-	12–18	$C_{28}H_{20}O_{14}$
Epitheaflavic acid gallate	-	-	-	-	$C_{21}H_{16}O_{10}$
Epitheaflavic acid gallate	-	-	-	-	$C_{21}H_{16}O_{10}$
Theaflavin (TF)	-	-	-	-	$C_{29}H_{24}O_{12}$
Isotheflavin	-	-	-	-	$C_{29}H_{24}O_{12}$
Theaflavin-3-monogallate (TF1)	-	-	-	-	$C_{29}H_{24}O_{12}$
Theaflavin-3-monogallate (TF2)	-	-	-	-	$C_{36}H_{28}O_{16}$
Epitheaflavic acid	-	-	-	Trace	$C_{21}H_{16}O_{10}$
Theaflavin acid	-	-	-		$C_{43}H_{32}O_{20}$
Theaflavin-3,3' -gallate (TF3)	-	-	-		$C_{36}H_{28}O_{16}$

Tab. 5. Black tea's molecular weight of its chemical components

Chemical Constituents	Color of Brew	Taste		Black Tea	Molecular Weight
		Taste Threshold Level (mol/L)			
Bisflavanol A	-	Astringent and bitter	-	Small amount	915
Others	-	-	-	Trace	-
Thearubigin-3 (TR3)	-	-	-	Trace	-
Thearubigin-2 (TR2)	-	-	-	Trace	-
Thearubigin-1 (TR1)	-	-	Ashy and slight astringent	Trace	-
Thearubigins (TRs)	Reddish brown	-	-	12–18	581
Epitheaflavic acid gallate		-	-	-	429
Epitheaflavic acid gallate	-	-	-	-	429
Theaflavin (TF)	-	-	-	-	565
Isotheflavin	-	-	-	-	565
(TF1)	-	-	-	-	565
(TF2)	-	-	-	-	717
(TF3)	-	-	-	-	717
Theaflavin acid	-	-	-	Trace	869
Epitheaflavic acid	-	-	-	-	429

Animal studies, however, have shown that black tea extract mitigates the negative effects of a high-cholesterol diet by enhancing lipid distributions in plasma and decreasing the degradation of LDL and VLDL by oxidation. Black tea's potential importance in preventing cardiovascular disorders stems from its ability to inhibit LDL oxidation and fatty acid synthase. Consumption of black tea protected mouse peritoneal macrophages against the damaging effects of NO and superoxide (O_2). Researchers have uncovered a chemical that is more efficient than green tea in preventing the harmful effects of chemotherapy, called TFs. Black tea extract pretreatment reduced LPO caused by carbon tetrachloride in livers by 49% in both male and female rats and 37%, respectively. The kidneys and testicles of rats also showed signs of protection. This result was linked to the removal of carbon tetrachloride-induced FRs. The oxidation of linoleic acid was similarly blocked when flavonoid-rich black tea extract was used. Protein cross-linking and oxidative DNA strand breaking were both thwarted by its aqueous extract. Animals given black tea extract also showed a decrease

in the oxidative stress normally brought on by smoking cigarettes. About 84% of the antioxidant activity was extracted in the first 5 minutes of brewing, and another 13% was removed after a further 5 minutes.

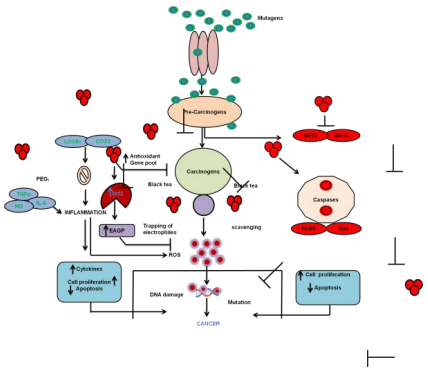

Fig. 4. Black tea's molecular evidence for its antioxidant, ant mutagenic and cancer-preventative properties is presented

30 healthy volunteers participated in a randomized trial where they were given a single bolus of black tea and then monitored for two hours to determine when their plasma antioxidant levels were at their highest. An examination employing the Oxygen Radical Absorbance Capacity test revealed that black tea has an average antioxidant of 761.1 m/mol. Trolox equivalents per gram of dry matter. Black tea flavonoids were reported to have strong antioxidant activity in vitro studies; however, no action was detected in vivo models. Flavonoid-rich black tea (450 mL/day) was shown to improve vascular function in humans after just four days of consumption. The research was done to back up these findings. CHD risk factor improvement was evaluated, but no discernible shift in antioxidant status was found. Black tea and its flavonoids have been shown to promote the control of diabetes, cardiovascular health carcinogenesis, thrombosis, endothelial function, and inflammation according to a large body of observational research.

Anticancer activity

Many researchers have shown the phytochemicals in black tea block tumour promoters, either directly or indirectly, to produce their chemo preventive effects. Black tea extract demonstrated chemo preventive efficacy by blocking hamster buccal pouch carcinogenesis model. This impact has been linked to TFs and TRs' ability to reduce oxidative stress, neoplastic lesion development, carcinogen metabolizing enzyme activity, and the occurrence of micronuclei in bone marrow, according to the literature. Additionally, both tumour invasion and cell proliferation were shown to be stifled by black tea. According to these findings, black tea has the potential to significantly slow the progression of cancer at various stages. Epidemiological studies did not consistently link black tea's cancer-fighting capability to a reduced cancer rate, however. However, black tea did not show any signs of being a carcinogen. The potential carcinogenicity of aflatoxin places it in the same category as other naturally occurring mycotoxins and food pollutants. Liver DNA, RNA, protein, and glycogen were all depleted after oral administration of aflatoxin, but cholesterol and phosphorylase activity were dramatically raised. When used in conjunction with black tea extract, these modifications were shown to be reverted. When TR and genistein were combined at a 1:40 concentration, they were able to slow the growth of human prostate cancer cells. Cell growth could not be significantly slowed by TR alone. The number of tumours in the mammary glands of DMBA-treated, high-fat-diet female Sprague Dawley rats was significantly lower compared to controls. Rats given the AIN-76A diet, on the other hand, showed no sign of this impact. The following sequence of TFs was discovered to have an inhibitory impact on the growth of prostate cancer LNCaP cells: TF4 inhibits 5a-R1 activity, which slows the expansion of androgen-sensitive LNCaP cells, more so than TF3>TF2>EGCG>TF1. Testosterone is a prostate cancer promoter; although TFs and TRs may neutralize the FRs it creates.

Black tea protects against oesophageal cancer caused by exposure to nitrosomethylbenzamide in male rats by a factor of 70%. However, these occurrences were suppressed after being treated with 0.1% and 0.3% solutions of TFs. Human Vascular Endothelial Cells (HUVECs) are less damaged after being treated with TFs, and oxidative DNA damage caused by homocysteine is prevented via the inhibition of FRs being quenched. For the skin cancer model in mice known as SENCAR, black tea reduced inflammation brought on by 12-O-tetradecanoyl phorbol-13-acetate. Several studies have shown inconsistencies in the findings of studies on black tea. The development of azoxymethane-induced Peyer's patch carcinomas in the colon was not slowed by chronic treatment with black tea. Contrary to popular belief, black tea promotes the development of exophytic carcinomas rather than inhibiting their spread. Drinking tea may raise your risk of bladder cancer, according to some research. Zeegers and collaborators noted later in their study that consuming tea reduces the development and spread of bladder cancer. The development of intestinal cancer is inhibited by the oral administration of black tea extract. The apoptotic index of tumours in rats is increased by black tea from 2.920.25 in controls to 4.130.46. The number of lung cancers in male C3H mice treated with NDEA was shown to be reduced after being exposed to black tea extract that had been decaffeinated. Black tea aqueous extract (4%) suppressed NDEA-induced lung tumour growth in Swiss albino mice. Both black and green tea is rich in antioxidants, which have been shown to have anti-cancer benefits. Normal cells were shown to be unaffected by TF1 and its gallates, whereas hepatoma AH109A and L929 tumour cells were inhibited in their ability to proliferate and invade. The fact that black tea lost its anticancer impact when EDTA has added hints at the potency of its antioxidants. Black tea aqueous extract was also tested for its ability to suppress skin cancer in female CD-1 mice caused by 7, 12-dimethyl Benz (a) anthracene by causing apoptosis and the death of cancer cells. Black tea consumption was also connected with a 35% to 40% reduction in papilloma development. In one instance, decaffeinated tea treatment inhibited papilloma development, whereas, in two others, it promoted growth. Skin cancer in SKH-1 female mice exposed to 30 mJ/cm^2 of UV-B radiation was reduced by 70% when the animals were

given black tea. Concentrated black tea extract (0.1 mg/mL-0.2 mg/mL) suppressed the development of tumours in the livers of male C3H mice exposed to NDEA. Furthermore, it was shown that the black tea's chemo preventive impact was due to its ability to inhibit Hepatoma cells from transgenic (HT) rats from replicate DNA. Black tea ethyl acetate extracts inhibited Cell division and replication of DNA in mouse erythroleukemia DS19 cells. Inhibiting UVB-mediated AP-1 activation by treating Epidermal cells from JB-6 mice that express TFs. Hairless mice were exposed to UV ACB light and subsequent pre-treatment number of papilloma's on their skin. Black tea had a more potent impact than any other kind of tea. Black tea's cancer-fighting properties have inspired a plethora of remedies. A combination of rhubarb, and high-quality black tea, for instance, is used to alleviate the pain of burns and scalds. For this reason, tea leaves, powder, pills, capsules, wine, beer, liquid medicines, candies, and biscuits may all be used to combat cancer.

Cancer prevention molecule targets

Black tea consumption has been linked to a reduced risk of developing many different malignancies. Black tea has been studied extensively over the last two decades, and its cancer-fighting polyphenols, which alter several cellular signalling pathways, have been linked to both cancer prevention and therapy (Figure 5). TFs has found to have similarities for every of chosen nuclear architecture in a cell, including his tone proteins, double-stranded DNA, and quadruplex DNA. The affinity of TF4 with quadruplex DNA was the greatest of any phytochemical studied to date. This research points to black tea's potential as a lifespan essential due to its cancer-preventative chemo preventive properties. The proteins known as growth factors connect to cell surface receptors and stimulate cell division; IGF-1 overexpression promotes cell proliferation, inhibits apoptotic signals, and promotes invasion and metastasis. Several advanced malignancies are studied for their ability to disrupt autocrine loops, and the fact that black tea and its TFs may block IGF-1 from causing prostate carcinoma DU145 cells to enter the S phase of the cell cycle is promising in this regard. In addition to decreasing mitochondrial membrane potential, polymerase (PARP). As a result of TF therapy, phosphorylation, loss of inhibitory effect of kBa and kBb subunits were all downregulated, which in turn inhibited AKT and NF-kB activation. NF-kB's transcriptional target cyclin D1 was another gene whose expression was dramatically suppressed by TF. To keep a biological system's homeostasis stable, it relies on a natural physiological process called apoptosis. As a result, controlling apoptosis might be an effective strategy in cancer treatment and prevention. Human breast cancer (MCF-7), colon cancer (HT-29), lung cancer (A-427), and melanoma (UACC-375) cell lines are inhibited in growth by tea polyphenols; this inhibition is apoptosis-dependent. Researchers discovered that suppressing IL-1b, IL-6, TNF-a, IL-10, glial fibrillary acidic protein, Bax, and Bcl-2 by oral therapy with TF1 (10 mg/kg) reduced Neuroinflammation and apoptosis brought on by 1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine. Black tea's impact was stated to be similar to that of green tea by these writers. Radiation-induced cell death, production, mitochondrial dysfunction, caspase-3 activation, and apoptosis were all mitigated in normal lymphocytes pre-exposed to black tea extract, but not in K562 cells. Furthermore, endogenous antioxidant enzyme activity is controlled by black tea extract. Alterations in the Messenger RNA (mRNA) expression of Bax, Nrf2, p53, and Bcl2 were also monitored to evaluate black tea extract's ability to inhibit radiation-induced apoptosis. Black tea induced apoptosis in KB cells from patients with oral squamous cell carcinoma, as measured by TUNEL and DNA fragmentation tests. For example, Cyclin-Dependent Kinase (CDK) is all downstream targets of activated AKT that regulate cell growth. AKT pathway activation and its downstream targets were shown to be inhibited by TF1 and TR. p19, p21, and p27 were all expressed at higher levels, whereas CDK2, CDK4, CDK6, and cyclin D1 were all down regulated. The regulation of arachidonic acid metabolism by cyclooxygenases, Lipo xygenases (LO), and cytochrome P450 (CYP450) is a well-accepted phenomenon for reducing colon cancer risk. Tumour cell proliferation, mitogenesis, invasiveness, and angiogenesis are all influenced by prostaglandin G2 (PGG2), which is produced when COX-2 is activated. Overexpression of COX-2 has been seen in colorectal cancer cells. Catechins lowered both COX-1 and COX-2 activity, leading to their anticancer activity, which is interesting given that TFs were reported to promote PGE2 production by boosting the COX-2 activity. Multiple studies have shown that TFs inhibit tumour growth and spread by decreasing tumour cell survival and triggering tumour cell death. The 33 SV40-WI 38, BES, 21 BES, and Caco-2 cell lines are among them. The phosphorylation of c-Jun was down-regulated by TF3 (25 mM), which reduced AP-1 activity and inhibited the proliferation of cancer cells. When used together, TF2 and TF3 reduce COX2 activity and induce apoptotic cell death, therefore suppressing the proliferation of colon cancer cells.

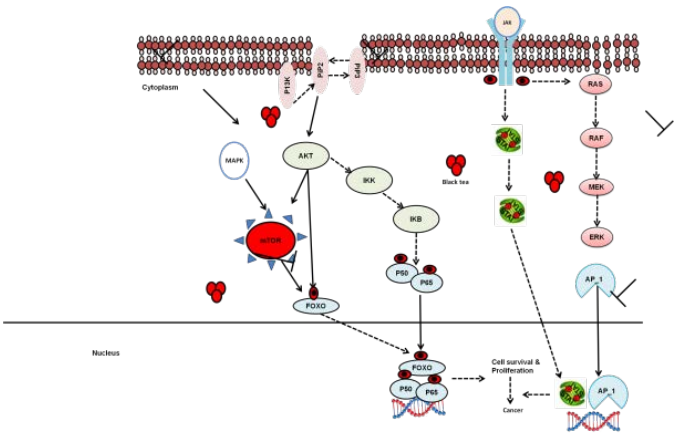

Fig. 5. Polyphenols in black tea may have a role in controlling oncogenic signalling pathways, making it a potential cancer therapy

Ehrlich's Ascites Carcinoma (EAC) is characterized by a decrease in splenic lymphocyte count, which compromises the host's immune system. Repeatedly seen is increased hydrogen peroxide formation in response to TFs and EGCG-induced apoptosis in H661 cells. It has been demonstrated that black tea causes leukemic cancer cell lines (HL-60 and K562) to undergo apoptosis, or suicide, and to limit their growth. Following these modifications, caspases and Bax were more highly expressed. Inhibition of the enzymes that cause tumours, such as Lipoxygenase (LOX), Cyclooxygenase-2 (COX-2), and ornithine decarboxylase. Depending on the dose, TF4 inhibits the growth of both mouse NIH3T3 fibroblasts and A431 cells. Nitric Oxide (NO) production, NF-kB activation, auto-phosphorylation of the Epidermal Growth Factor Receptor (EGFR).

CONCLUSION

Black tea and its extracts have several health-promoting qualities that are backed by a wealth of evidence from in vivo studies and human clinical trials. Theaflavins and catechins, the two main black tea polyphenols, should be acknowledged as bimolecular indicators of black tea and its extract. It will be essential knowledge for product development to identify the biological pathways linked to a well-characterized chemical profile to target certain situations. The initiation of the Nrf2 transcription factor, which increases the activity of detoxifying and antioxidant enzymes. The transcription factor master function may potentially suppress NF-B, which regulates inflammation. The scientific evidence for the use of black tea inflammatory and metabolic illnesses as well as the prevention of cancer comes from all these various effects.

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