THE 4TH AFRICAN TEA CONVENTION AND EXHIBITION

TEA CONSUMPTION FOR HEALTH FOOD NUTRITION AND SECURITY

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Outline of the Presentation

- Plants as a source of antioxidants
- The tea plant
- History of tea and its use for health purposes
- Components of tea attributed to its health benefits
- Modern day examples of teas health benefits for controlling various conditions
- Tea consumption for health benefits
- Detrimental effects of tea consumption
- Conclusion

The tea plant

- Tea *Camellia sinensis* is the species of plant used to produce tea.
- It is of the genus *Camellia* of flowering plants in the family *Theaceae* (Willson and Clifford, 1992).
- Its two major varieties in the species (1) *Camellia sinensis var. sinensis* (L.) Kuntze and (2) *Camellia sinensis var. clonal assamica* (Masters) Kitam
- Tea was first used and cultivated by the Chinese, then it spread to the rest of the world.
- Today tea is cultivated in several countries and is the most widely consumed beverage after water.

History of tea and its use for health purposes

- Tea was initially used as medicine by the Chinese for stomach ailments, indigestion, cleaning of wounds.
- Studies suggest that tea consumption has many health benefits because of its antioxidants.
- Tea also has antimicrobial properties.
- Utilization of tea in product diversification and the development of health products is ongoing

Production of free radicles in the human body

- Free radicals and other ROS are derived either from normal essential metabolic processes or external sources.
- Free radical formation occurs continuously in cells as a consequence of enzymatic & non-enzymatic reactions.
- Enzymatic reactions, include those in the respiratory chain, phagocytosis, prostaglandin synthesis, and the cytochrome P-450 system.
- Non-enzymatic reactions include those of oxygen with organic compounds as well as those initiated by ionizing reactions.

Free radicals in biology

- Free radical reactions produce progressive adverse changes that accumulate with age throughout the body
- Such changes are influenced by genetics and environmental differences that modulate free radical damage.
- These are manifested as diseases at certain ages.
- Cancer and atherosclerosis are 2 major causes of death, influenced by free radicals.
- Cancer initiation and promotion is associated with chromosomal defects and oncogene activation.
- Endogenous free radical reactions may result in leukemia, tumors of the breast, ovaries, and rectum.
- Atherosclerosis may result from free radical reactions involving diet-derived lipids to yield peroxides and other substances.

SOURCES OF FREE RADICLES

Some internally generated sources of free radicals are

- Mitochondria
- Xanthine oxidase
- Peroxisomes
- Inflammation
- Phagocytosis
- Arachidonate pathways
- Exercise
- Ischemia/reperfusion injury

Some externally generated sources of free radicals are:

- Cigarette smoke
- Environmental pollutants
- Radiation
- Drug abuse
- Pesticides
- Industrial solvents
- Ozone

CONCEPT OF OXIDATIVE STRESS

- Oxidative stress results when the critical balance between free radical generation and antioxidant defenses is unfavorable.
- It is associated with damage to a wide range of molecular species including lipids, proteins, and nucleic acids.
- Short-term oxidative stress may occur in tissues injured by trauma, infection, heat injury, hypertoxia, toxins, and excessive exercise.
- Injured tissues produce increased radical generating enzymes (e.g., xanthine oxidase, lipogenase, cyclooxygenase)
- Activation of phagocytes releases free ions disrupting the electron transport chains of oxidative phosphorylation, producing excess ROS.
- The initiation, promotion, and progression of cancer, as well as the side-effects of radiation and chemotherapy, have been linked to the imbalance between ROS and the antioxidant defense system.
- ROS have been implicated in the induction and complications of diabetes mellitus, age-related eye disease, and neurodegenerative diseases such as Parkinson's disease

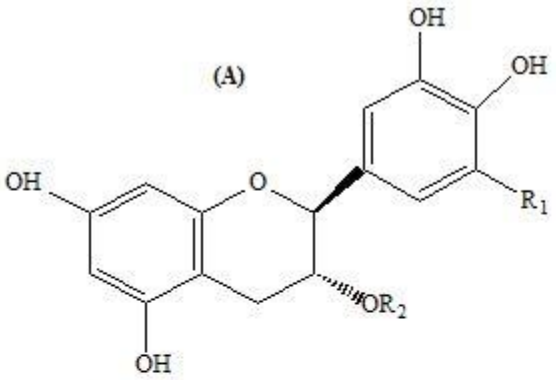
STRESSANTIOXIDANTS

- An antioxidant is a molecule stable enough to donate an electron to a rampaging free radical and neutralize it.
- These antioxidants delay or inhibit cellular damage mainly through their free radical scavenging property.
- These low-molecular-weight antioxidants can safely interact with free radicals and terminate the chain reaction before vital molecules are damaged.
- Body antioxidants, include glutathione, ubiquinol, and uric acid, are produced during normal metabolism in the body.
- Although there are several enzymes system within the body that scavenge free radicals, the body cannot manufacture these micronutrients, so they must be supplied in the diet.
- Diet supplied antioxidants include vitamin E (α-tocopherol), vitamin C (ascorbic acid), and B-carotene.

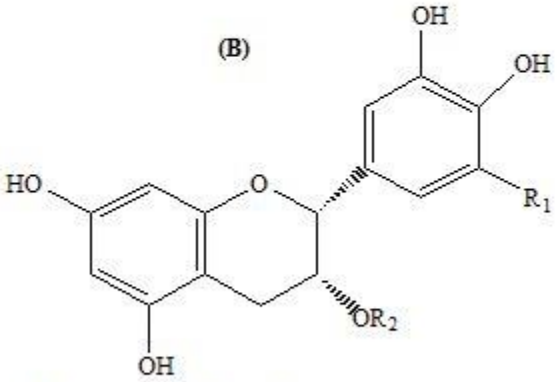
PLANTS AS SOURCE OF ANTIOXIDANTS

- Synthetic and natural antioxidants are used in the food, cosmetics, and therapeutic industry to protect against oxidation.
- Synthetic phenolic antioxidants include butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA).
- Disadvantages-high volatility, instability, strict legislation, carcinogenicity.
- Preferences have shifted from synthetic to natural antioxidants.
- Advantages of natural antioxidants include low cost, compatibility and safety inside the human body.
- Inverse relationship between the dietary intake of antioxidant-rich foods and medicinal plants and incidence of human diseases.
- Naturally occurring antioxidants, are free radicals/ active oxygen scavengers.
- Green and black teas contain up to 30% DW as phenolic compounds.

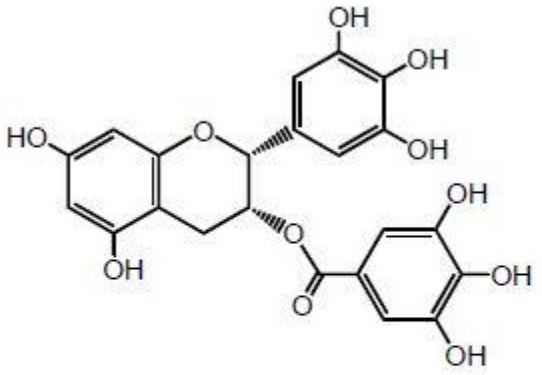
Tea biomolecules



Catechin: R_1=R_2=H
Gallocatechin: R_1=OH, R_2=H
Catechin 3-gallate: R_1=H, R_2=Galloyl
Gallocatechin 3-gallate: R_1=OH, R_2=Galloyl

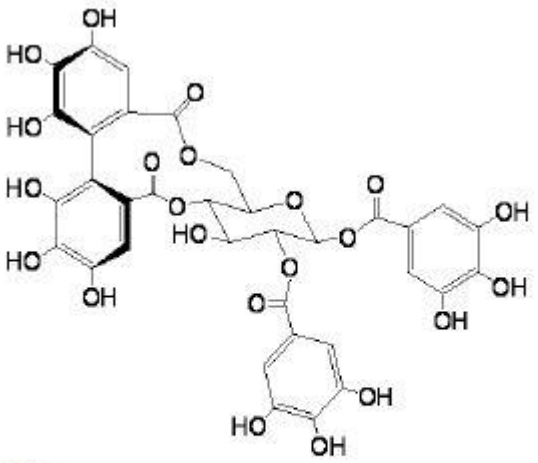


Epicatechin: R_1=R_2=H
Epigallocatechin: R_1=OH, R_2=H
Epicatechin 3-gallate: R_1=H, R_2=Galloyl
Epigallocatechin 3-gallate: R_1=OH, R_2=Galloyl

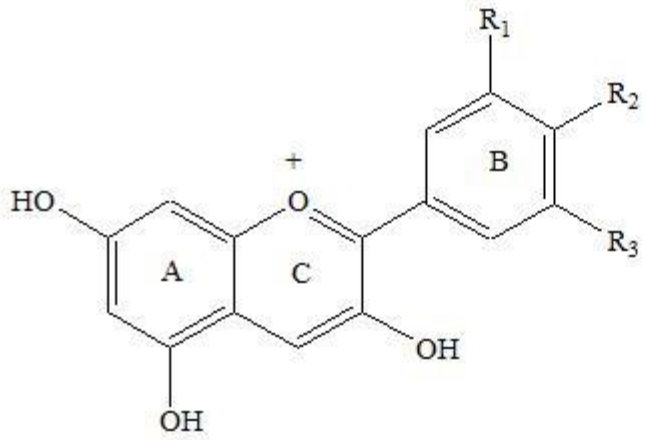


EGCG
(**E**pi**G**allo**C**atechin **G**allate)

Tea biomolecules



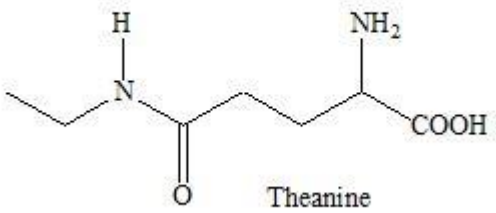
GHG
(1,2-di-**G**alloyl-4,6-**H**exahydroxydipheno
yl-β-D-**G**lucose)



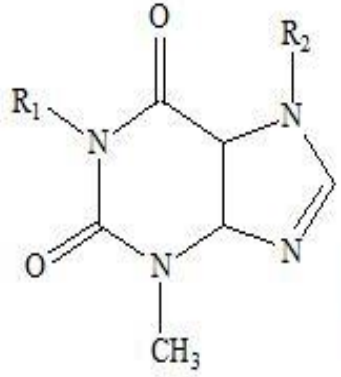
Anthocyanidins
Cyanidin: R_1=R_2=OH, R_3=H
Delphinidin: R_1=R_2=R_3=OH
Malvidin: R_1=R_3=OCH_3, R_2=OH
Pelargonidin: R_1=R_3=H, R_2=OH
Peonidin: R_1=OCH_3, R_2=OH, R_3=H
Petunidin: R_1=OCH_3, R_2=R_3=OH

Tea biomolecules

(E)



Theanine



(B)

Caffeine: R_1=R_2=Me
Theobromine: R_1=H, R_2=Me
Theophylline: R_1=Me, R_2=H

Modern day examples of teas health benefits for controlling various conditions

- Tea contains enzymes, amino acids, carbohydrates, lipids, sterols, related compounds, and dietary minerals.
- Tea provides photo protection, increases microcirculation and modulates skin properties
- Tea contains alkaloids like caffeine, theobromine, and theophylline which impart stimulant effects.
- L-theanine (amino acid) in non-aerated tea has calming effects on the nervous system
- Non-aerated green tea- have higher phytochemicals (flavonoids) than in other foods traditionally considered to be of health contributing nature, like fresh fruits, vegetable juices or wine (USDA, 2011).
- Animal studies (in vivo) have shown that green tea may have anti-cancer, anti-hypertensive, anti-inflamatory, anti-athritis, anti-microbial and anti-diabetic properties (Johnson et al., 2012).
- Non-aerated green tea induces thermogenesis and stimulates fat oxidation by boosting the metabolic rate by 4% without increasing the heart rate, thus lowering the risk of developing heart disease and certain types of cancers (Golden, et al., 2009).
- On the other hand there is also evidence suggesting that consuming large volumes of non-aerated green tea, and in particularly non-aerated green tea extracts, may cause oxidative stress and liver toxicity (Lambert et al., 2007).

Components of tea attributed to its health benefits

- Tea is composed of different biochemical components which imparts unique characteristics. These include; polyphenols, (catechins and anthocyanins), caffeine, cardohydrates, proteins, minerals, enzymes and vitamins
- The chemical components gives tea unique properties including; antioxidation,
- anti-inflamation,
- boosting of the bodys' immune system,
- anti-cancer,
- prevention of cardiovascular diseases
- anti-microbial properties
- These properties can be imparted to food products by fortification with tea.

Anti-ageing of skin

Inhibition of lipid peroxidation

- Lipid peroxidation occurs when lipids In the cell membrane undergo oxidative degradation
- This May be caused by exposure of cells to ultraviolet light
- Chain reactions from lipid peroxidation may result in increased accumulation of lipid peroxide that is responsible for ageing skin, cell damage and inflammation

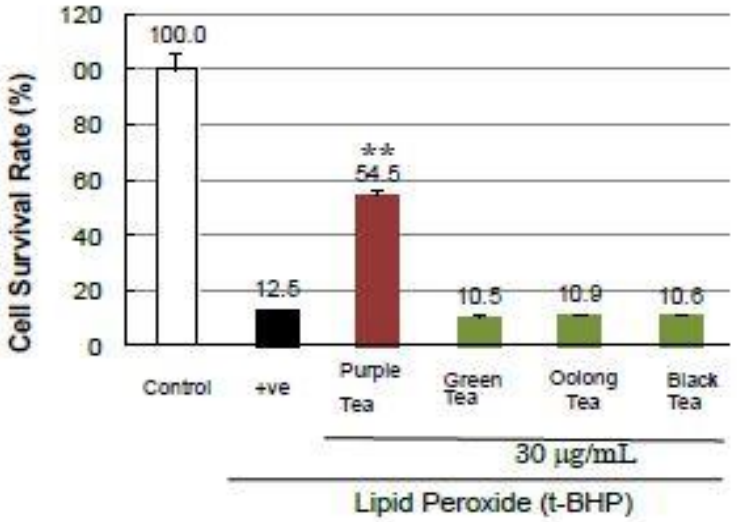
Lipid peroxidation

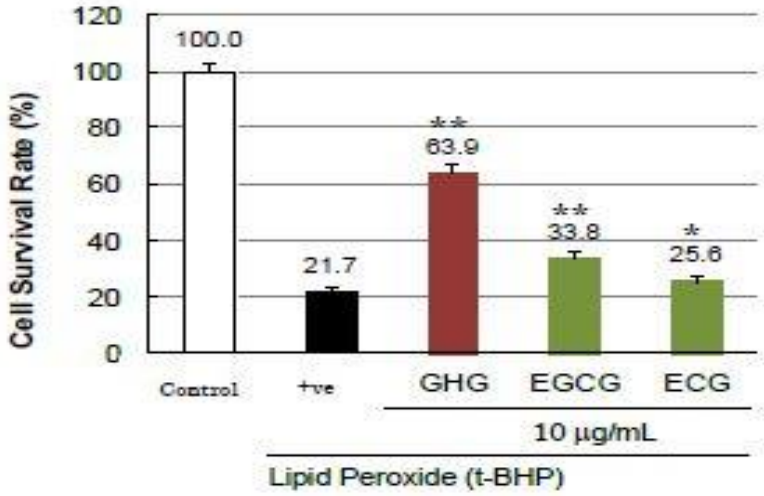
- Oxidative stress and oxidative modification of biomolecules are involved in a number of physiological and pathophysiological processes such as aging, artheroscleosis, inflammation and carcinogenesis, and drug toxicity.
- Lipid peroxidation is a free radical process involving a source of secondary free radical, which further can act as second messenger or can directly react with other biomolecule, enhancing biochemical lesions.
- Lipid peroxidation occurs on polysaturated fatty acid located on the cell membranes and it further proceeds with radical chain reaction. Hydroxyl radical is thought to initiate ROS and remove hydrogen atom, thus producing lipid radical and further converted into diene conjugate.
- Further, by addition of oxygen it forms peroxyl radical; this highly reactive radical attacks another fatty acid forming lipid hydroperoxide (LOOH) and a new radical. Thus lipid peroxidation is propagated.
- Due to lipid peroxidation, a number of compounds are formed, for example, alkanes, malanoaldehyde, and isoprotanes.
- These compounds are used as markers in lipid peroxidation assay and have been verified in many diseases such as neurogenerative diseases, ischemic reperfusion injury, and diabetes.

Tea inhibition on lipid peroxidation

- Tea extracts have shown excellent inhibitory effects against lipid peroxidation in human cell epidermal keratinocytes
- Chain reactions from lipid peroxidation may result in increased accumulation of lipid peroxides that is responsible for ageing skin, cell damage and inflammation

Different teas and lipid peroxidation





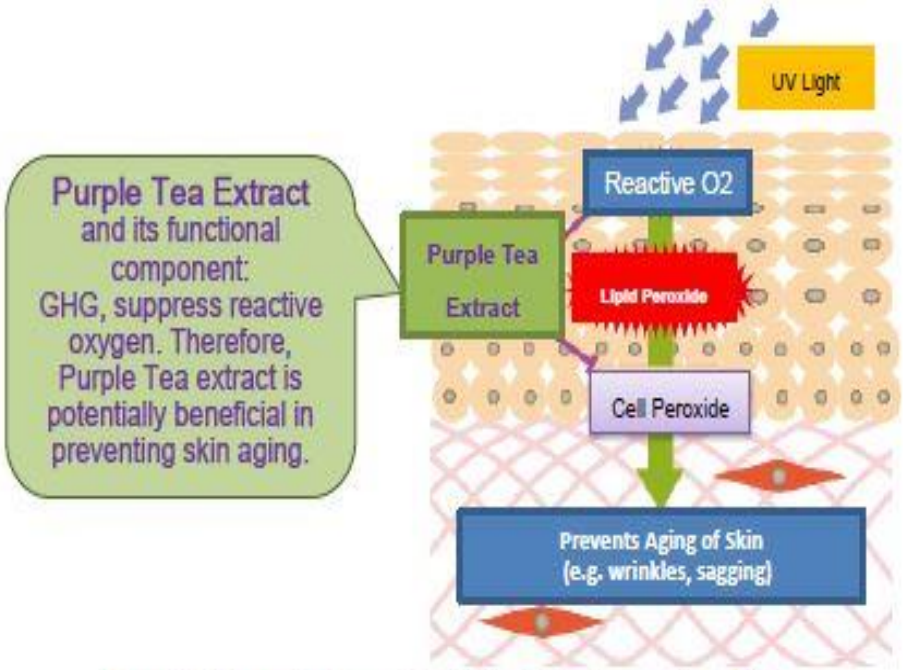
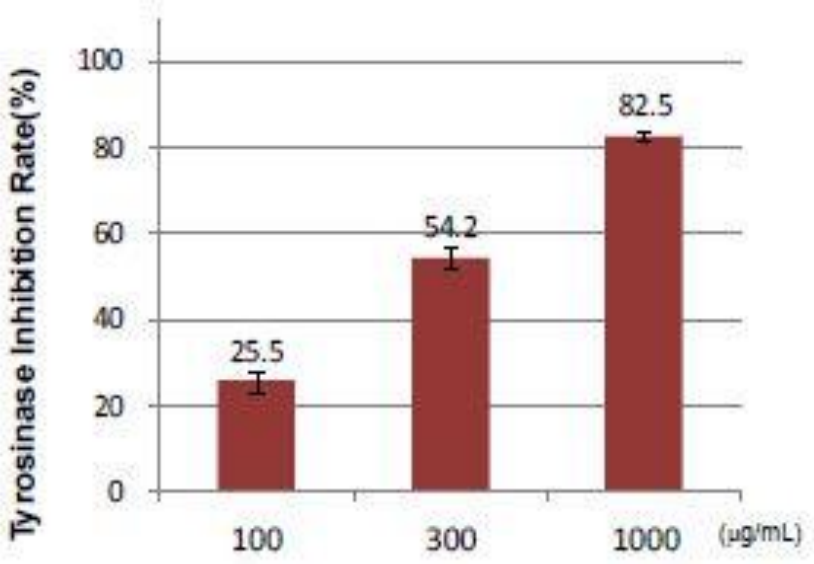


Figure 15: The mechanism of Purple Tea Extract on ageing of skin

Whitening Effects of purple tea extract

- Melanin is responsible for the formation of freckles and dark sports on the skin upon UV exposure
- Tyrosine is the enzyme that catalyzes the production of melanin.
- Purple tea extract inhibited the activity of tyrosine in a dose-dependent manner-suggesting that it may have skin lightening effect

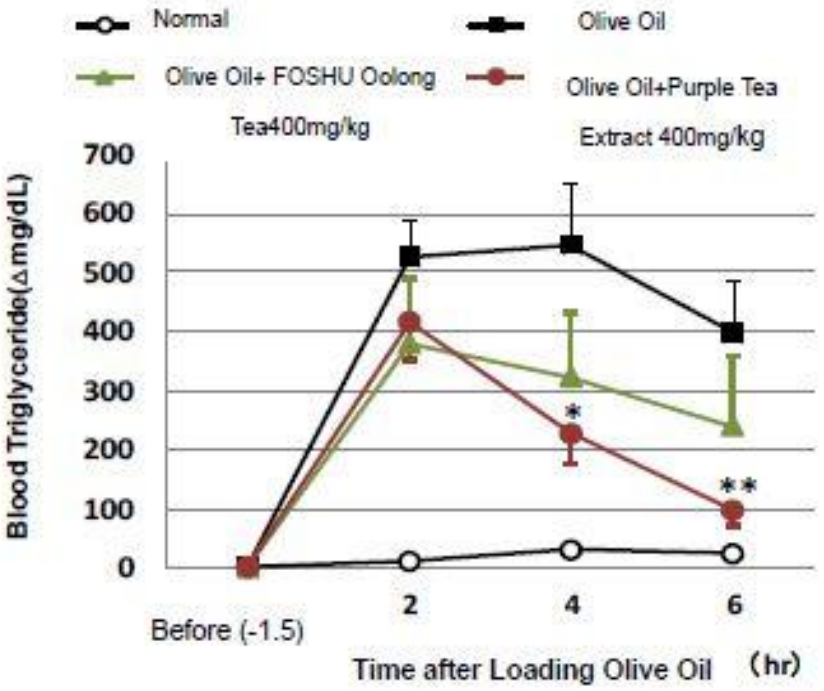


Effect of purple tea extract on tyrosine activity

Anti-obesity effect of Oolong and Purple tea

Inhibition of lipid absorption

- Oolong tea reduces lipid absorption as FOSHU
- At the same conc. inhibitory effect of purple tea was stronger than commercially available Food for Specific Health Use (FOSHU) Oolong tea extract
- Purple tea extract showed strong inhibitory effect on lipid absorption in mice-loading olive oil in mice

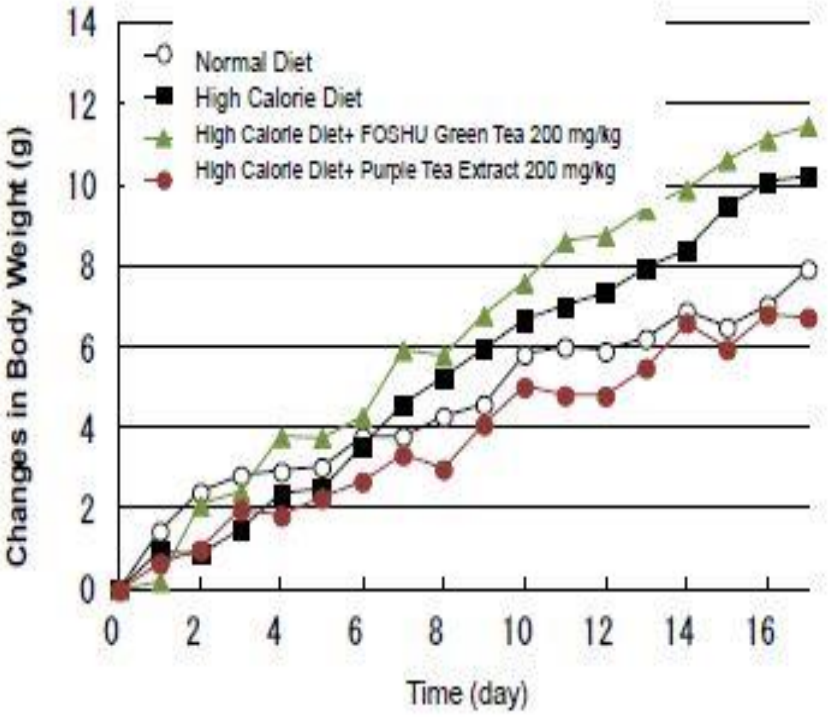


- The effect of purple tea extract and lipid absorption

Anti-obesity effect of green and purple tea

Inhibition of Fat accumulation

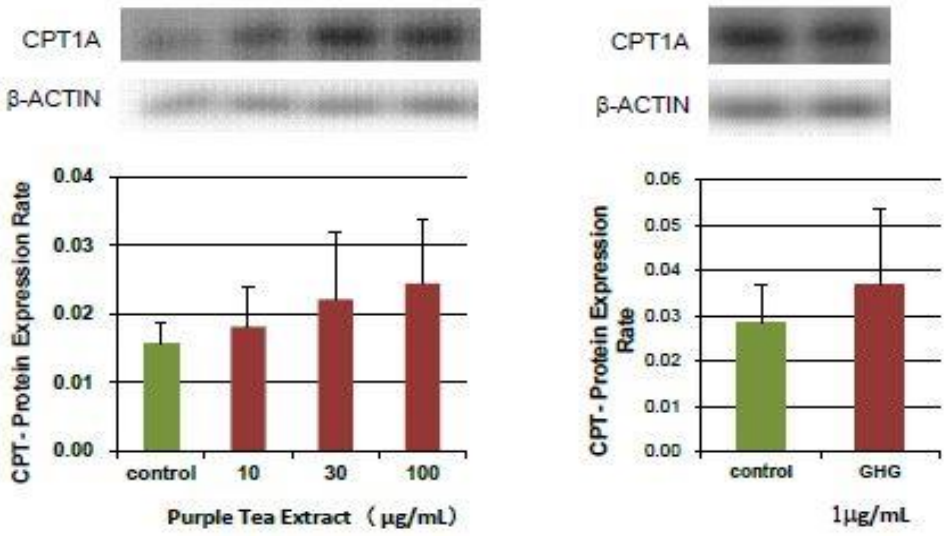
- Green tea is used to control body weight
- FOSHU-Green Tea Extract
- Purple tea extract suppresses weight gain on experimental mice on high calories diet
- The effects were better than those produced by mice fed on FOSHU
- Purple tea demonstrated a stronger effect in the prevention of weight gain caused by high calorie diet



The effect of purple tea extract on weight gain

Improvement in fat metabolism and purple tea extract

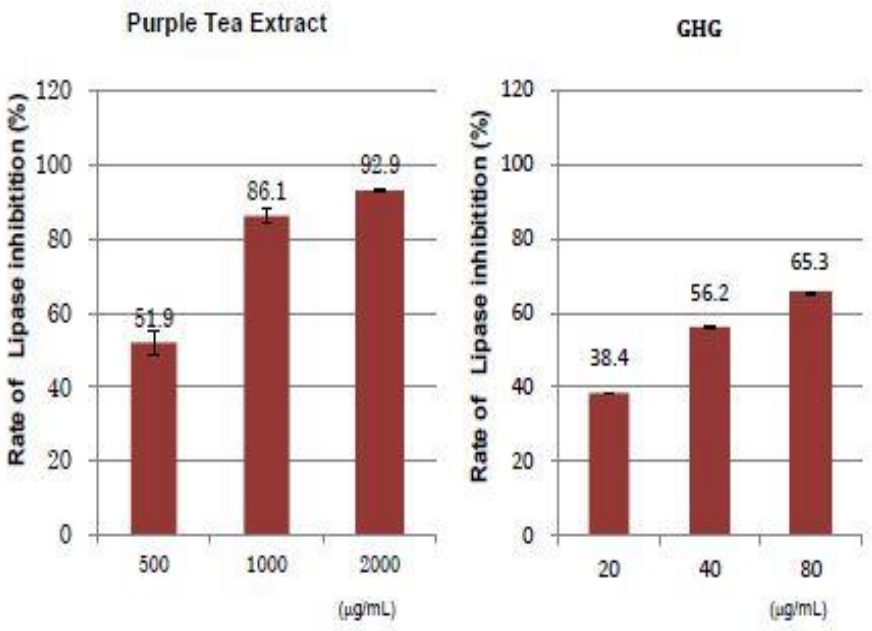
- Fatty acids are released from the adipose tissue to the leaver for metabolism
- Fatty acids are transported to the mitochondria in the hepatocytes undergoing beta oxidation for energy production
- Fatty acids are transported across the mitrochondria membrane by carnitine palmitol transferase(CPT-1) which is a rate limiting enzyme in beta oxidation process.
- Purple tea extracts and GHG is believed to improve fat metabolism in the hepatocytes



The Effect of Purple tea Extract on the expression of CPT in hepatocytes

Inhibition of Pancreatic lipase

- Purple tea extract and its functional component GHG inhibited pancreatic lipase activity
- Pancreatic lipase is the enzyme involved in the degradation and absorption of fat in the intestine
- Purple tea extract is recommended as FOSHU for



The effect of purple tea extract and GHG on pancreatic lipase

REMEMBER

"Okay, but each pound counts as a separate wish!"

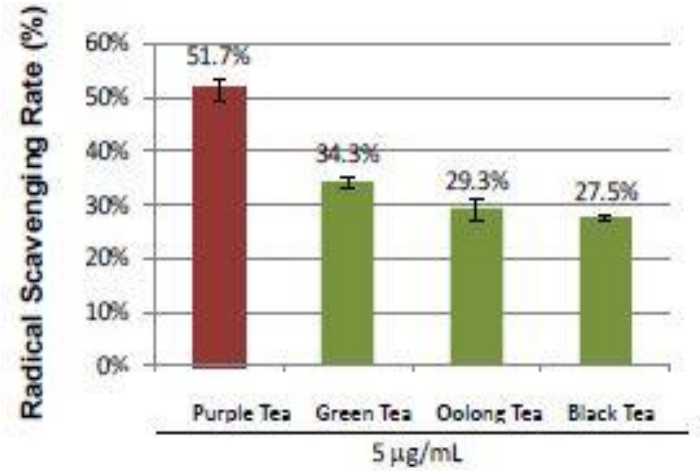
Tea can help reduce weight

ANTI-OXIDANTS

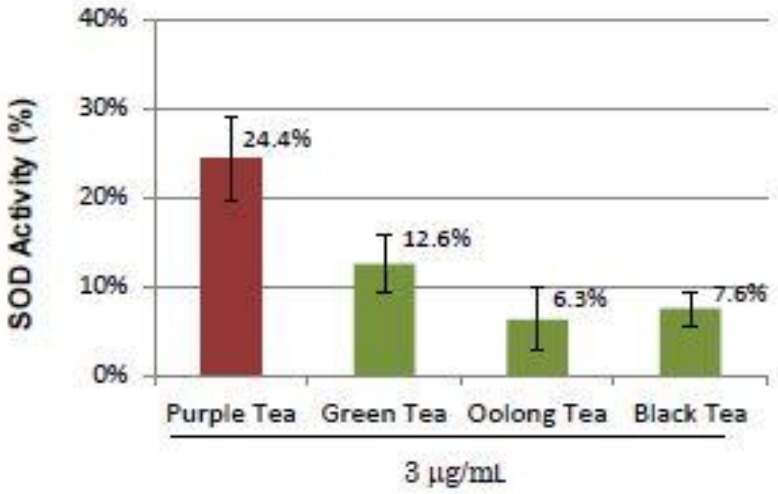
- Antioxidants are reducing agents that prevent oxidative reactions, often by scavenging ROS.
- Both enzymatic and non-enzymatic antioxidants exist in the intracellular and extracellular environment to detoxify ROS.
- Antioxidants act as radical scavengers, hydrogen donor, electron donor, peroxide decomposer, singlet oxygen quencher, enzyme inhibitor, synergist, and metal-chelating agents.
- Mode of action 1 - Chain- breaking mechanism by which the primary antioxidant donates an electron to the free radical present in the systems.
- Mode of action 2- Removal of ROS/reactive nitrogen species initiators (secondary antioxidants) by quenching chain-initiating catalyst..
- Antioxidants defense systems include preventive, radical scavenging, repair and de novo, and adaptation modes.

Antioxidant effect of different teas

- Reactive oxygen species (ROS) are generated through normal metabolism.
- ROS levels may be accelerated by environmental stress such as UV exposure and oxidative stress due to modern lifestyle
- All teas have antioxidant effects purple, green oolong and black
- Purple tea extract demonstrated strong antioxidant effect on DPPH and SOD



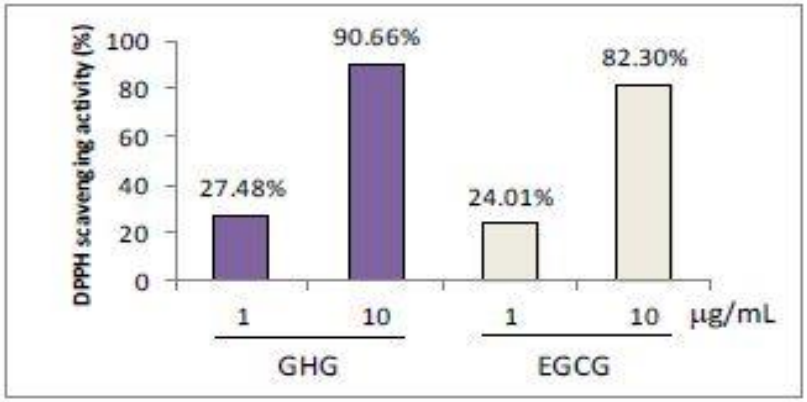
The effect of different tea extracts on DPPH radical scavenging model.

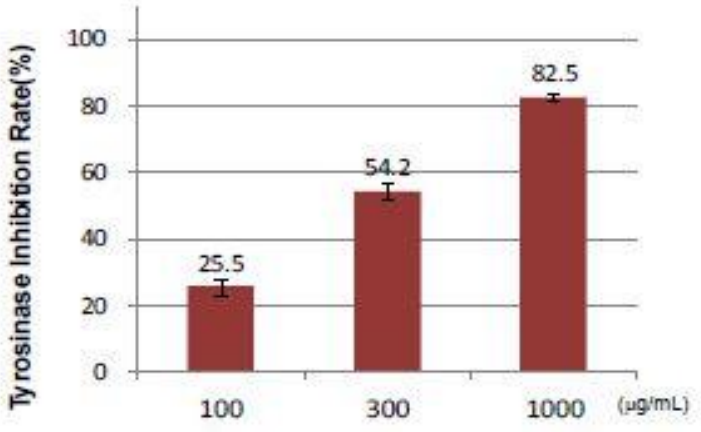


Antioxidant effects of tea

A comparison of Purple and white teas on antioxidant properties

- The antioxidant properties of purple tea and white teas were compared by checking their activity against DPPH
- Tea extracts GHG and EGCG were also compared
- Purple tea and GHG exhibited greater antioxidant activities compared to white tea and EGCG respectively





Antioxidant activity of Purple tea , white tea, GHG and EGCG

Tea consumption for health benefits

- How should you consume tea ?
- How often should tea be consumed?
- Which teas are good for what?
- In what format can teas be consumed?

Detrimental effects of tea consumption

- Discoloration of teeth
- Headaches
- Iron absorption
- Hyperactivity
- Insomnia

CONCLUSION

- Free radicals damage contributes to the etiology of many chronic health problems such as cardiovascular and inflammatory disease, cataract, and cancer.
- Antioxidants prevent free radical induced tissue damage by preventing their formation, scavenging them, or by promoting their decomposition.
- In addition to endogenous antioxidant defense systems, consumption of dietary antioxidants appears to be a suitable alternative.
- Synthetic antioxidants are reported to be dangerous to human health. Thus nontoxic natural plant-derived antioxidants like tea are preferred.
- Consumption of tea will provide the body with the needed antioxidants to enable it to neutralize the free radicles.

HAVE YOUR CUP OF TEA

THE END

THANK YOU

MEDICINAL PLANTS WITH ANTIOXIDANT PROPERTIES (with common/ayurvedic names in brackets)

- *Acacia catechu* (kair),
- *Aegle marmelos* (Bengal quince, Bel),
- *Allium cepa* (Onion),
- *A. sativum* (Garlic, Lahasuna),
- *Aleo vera* (Indain aloe, Ghritkumari),
- *Amomum subulatum* (Greater cardamom, Bari elachi),
- *Andrographis paniculata* (Kiryat),
- *Asparagus recemosus* (Shatavari),
- *Azadirachta indica* (Neem, Nimba),
- *Bacopa monniera* (Brahmi),
- *Butea monosperma* (Palas, Dhak),
- *Camellia sinensis* (Green tea),
- *Cinnamomum verum* (Cinnamon),
- *Cinnamomum tamala* (Tejpat),
- *Curcma longa* (Turmeric, Haridra),
- *Emblica officinalis* (Inhian gooseberry, Amlaki),
- *Glycyrrhiza glapra* (Yashtimudhu),
- *Hemidesmus indicus* (Indian Sarasparilla, Anantamul),
- *Indigofera tinctoria,*
- with common/ayurvedic names in brackets
- *Mangifera indica* (Mango, Amra),
- *Momordica charantia* (Bitter gourd),
- *Murraya koenigii* (Curry leaf),
- *Nigella sativa* (Black cumin),
- *Ocimum sanctum* (Holy basil, Tusil),
- *Onosma echioides* (Ratanjyot),
- *Picrorrhiza kurroa* (Katuka), Piper beetle,
- *Plumbago zeylancia* (Chitrak),
- *Sesamum indicum, Sida cordifolia,Spirulina fusiformis* (Alga), Swertia decursata, Syzigium cumini (Jamun),
- *Terminalia ariuna* (Arjun),
- *Terminalia bellarica* (Beheda),
- *Tinospora cordifolia* (Heart leaved moonseed, Guduchi),
- *Trigonella foenum-graecium* (Fenugreek),
- *Withania somifera* (Winter cherry, Ashwangandha), and
- *Zingiber officinalis* (Ginger).

FREE RADICLES

S/No.	Free radicles	Description
1.	O_2- Superoxide anion	One-electron reduction state of O_2 formed in many autoxidation reactions and by the electron transport chain. Rather unreactive but can release Fe^{2+} from iron sulphite proteins and ferratin . Undergoes dismutation to form H_2O_2 spontaneously or by enzymatic catalysis and is a precursor for metal catalyzed OH formation.
2.	H_2O_2 Hydrogen peroxide	Two –electron reduction state formed by dismutation of O_2 or by direct reduction of O_2. Lipid soluble and thus able to diffuse across membranes.
3.	OH, Hydroxyl radical	Three –electron reduction state, formed by Fenton reaction and decomposition of peroxynitrite. Extremely reactive , will attack most cellular components
4.	ROOH, organic hydroperoxides	Formed by radical reactions with cellular components such as lipids and nucleobases
5.	RO alkoxy and ROO peroxy radicles	Oxygen centered organic radicles. Lipid forms participate in lipid peroxidation reactions. Produced in the presence of oxygen by radical addition to double bonds or hydrogen abstraction
6.	HOCl Hypochlorous acid	Formed from H_2O_2 by myeloperoxidase. Lipid soluble and highly reactive. Will readily oxidize protein constituents, including thiol groups , amino groups and methionine
7.	ONOO-peroxynitrite	Formed in rapid reaction between O_{2-} and NO. Lipid soluble and similar in reaction to hypochlorous acid. Protonation forms peroxynitrous acid which can undergo hemolytic cleavage to form hydroxyl radical and nitrous dioxide

Variations of minerals of tea with seasons

Mth	N	P	K	Ca	Mg	Mn	Zn	Cu	Fe
Oct	3.86^{b}	0.26^{c}	1.80^{b}	0.50^{cde}	0.18^{abc}	0.17^{bc}	84.94^{a}	84.67^{a}	73.28^{f}
Nov	3.41^{cde}	0.22^{d}	2.51^{a}	0.42^{f}	0.13^{de}	0.19^{ab}	8.72^{e}	9.06^{d}	284.11^{c}
Jan	3.46^{cd}	0.23^{d}	1.94^{b}	0.47^{de}	0.12^{de}	0.20^{a}	29.78^{d}	20.89^{b}	104.56^{e}
Feb	3.19^{e}	0.27^{bc}	2.09^{ab}	0.55^{ab}	0.17^{bc}	0.20^{a}	14.83^{e}	6.83^{d}	363.39^{a}
Mar	3.20^{e}	0.28^{bc}	2.10^{ab}	0.56^{a}	0.19^{a}	0.20^{a}	15.01^{de}	6.99^{d}	363.52^{a}
Apr	3.30^{de}	0.21^{d}	1.82^{b}	0.51^{bcd}	0.16^{bc}	0.20^{a}	20.30^{c}	6.76^{cd}	324.37^{b}
May	4.21^{a}	0.34^{a}	1.97^{b}	0.53^{abc}	0.17^{ab}	0.21^{a}	42.31^{c}	10.25^{cd}	128.14^{d}
Jun	4.22^{a}	0.35^{a}	1.98^{b}	0.54^{abc}	0.18^{ab}	0.20^{a}	42.48^{c}	10.36^{cd}	128.26^{d}
Jly	4.21^{a}	0.34^{a}	1.98^{b}	0.53^{ab}	0.18^{ab}	0.19^{ab}	42.39^{c}	10.31^{cd}	128.21^{d}
Aug	3.57^{c}	0.28^{bc}	1.68^{b}	0.45^{ef}	0.12^{e}	0.13^{d}	55.44^{b}	19.94^{bc}	121.39^{de}
Sep	3.59^{c}	0.29^{b}	1.70^{b}	0.47^{de}	0.14^{d}	0.14^{cd}	56.44^{b}	20.84^{b}	122.42^{de}
Oct	3.58^{c}	0.28^{b}	1.69^{b}	0.46^{ef}	0.13^{de}	0.13^{cd}	55.94^{b}	20.39^{bc}	121.90^{de}
Mean	3.65	0.28	1.94	0.5	0.16	0.18	39.05	18.94	188.63
LSD	0.25	0.03	0.47	0.05	0.02	0.03	12.36	10.24	20.01

Fluoride in Tea

TABLE 1. Mean fluoride concentration in tea infusions of different grades of tea

Tea grade	Sample size	Fluoride concentration (µg F⁻ ml⁻¹)		
		Minimum	Maximum	Mean±SD
BP1	33	0.11	0.98	[a]0.40±0.22
PF1	35	0.26	0.40	[a]0.40±0.04
PD	35	0.20	0.95	[a]0.39±0.20
D1	6	0.25	0.36	[a]0.33±0.05
D2	1	0.37	0.47	[a]0.43±0.05
Fannings	1	0.27	0.49	[a]0.37±0.11
BMF	1	0.37	0.44	[b]0.32±0.10
Grand mean		0.26	0.58	0.37±0.04
Coefficient of variation (%)				11
LSD (P=0.05)				0.09

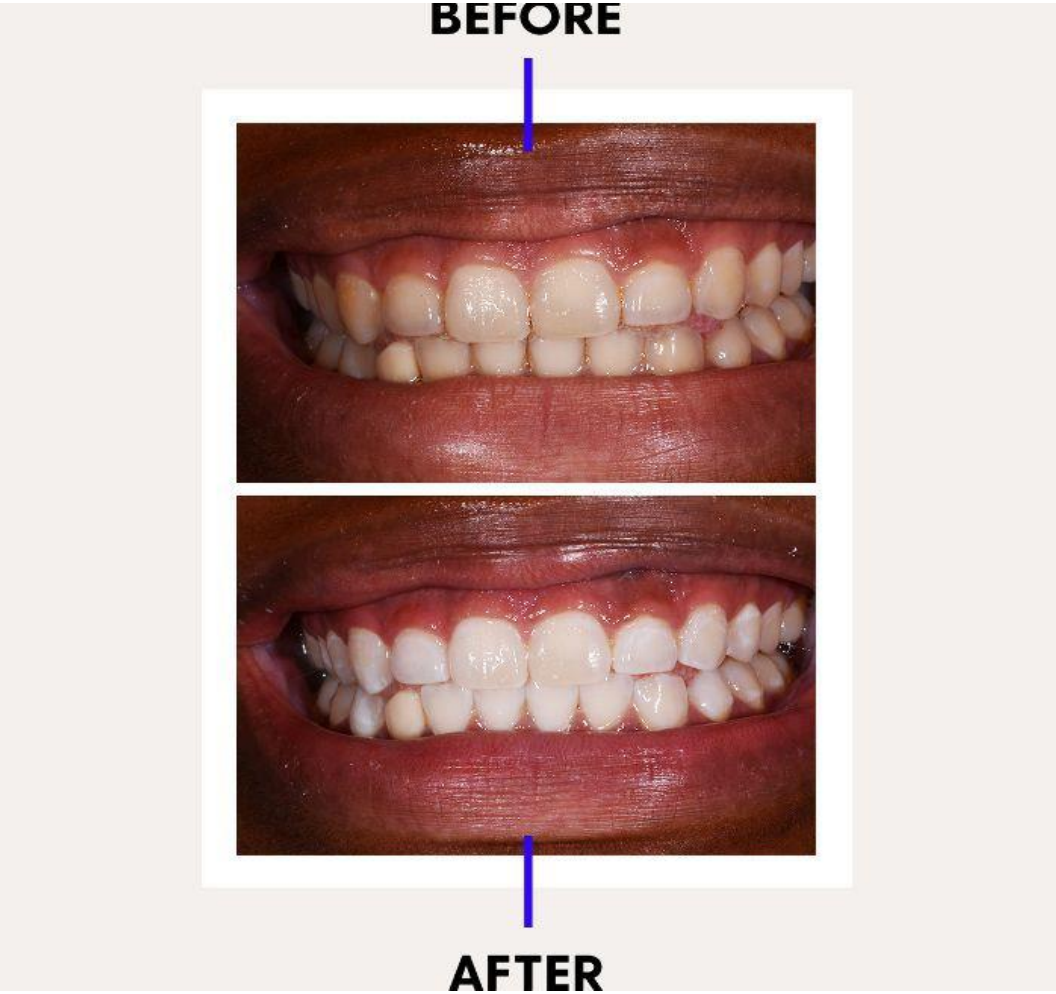
Means preceded with a similar letter are not significantly different (P>0.05)

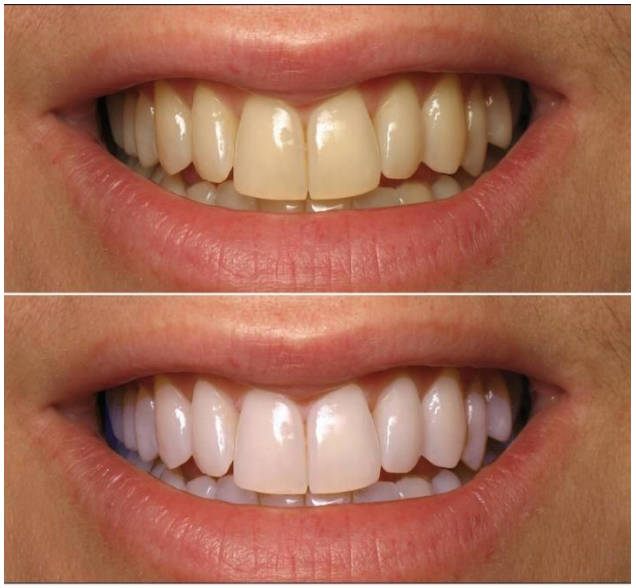
- Who Guidelines of fluoride in water 1.5micro g/mL
- Our teas fluoride levels were all below this limit
- Our teas are safe

Minerals found in tea

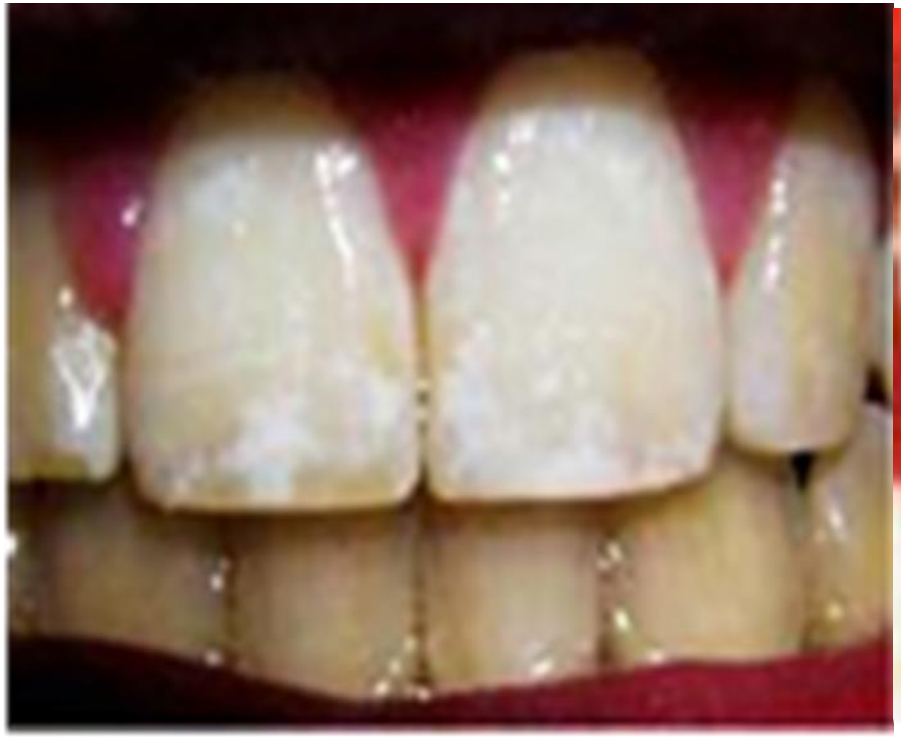
- Nitrogen
- Phosphorous
- Potassium
- Calcium
- Magnesium
- Manganese
- Zinc
- Copper
- Iron

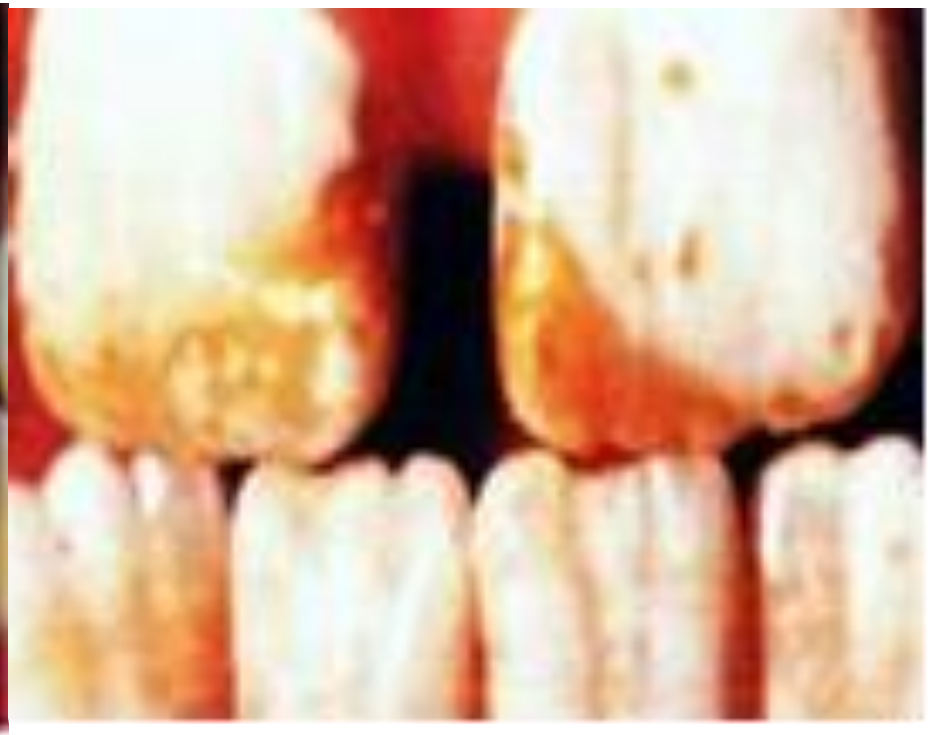
Teeth Discoloration and cleaning





Discoloration of teeth





Hyperactivity

Smoking

Environmental pollution

Pesticide Application

Industrial Solvents

Drug Abuse

Effects of Radiation