Kiwi Fruit (*Actinidia Deliciosa*)- Therapeutic Benefits and Application in Dairy and Food Industry

Ganesh[1*], Harshitha[1], Chethan D[1], Akshata Patil[2]
[1]M.Tech, Dairy Science College, Hebbal, Bangalore- 560 024.
[2]Ph.D. Scholar, Department of Animal Genetics and Breeding, NDRI, Karnal, Haryana.
Correspondent author: ganeshyarnalle1997@gmail.com

Fruit, the fleshy or dry ripened ovary of a flowering plant, enclosing the seed or seeds. Fruit is usually classified as simple fruit, aggregate fruit, composite fruit. Kiwifruit is a non-citrus exotic fruit**.** The genus Actinidia is known for the famous 'kiwifruit' (A. deliciosa). Kiwifruit is native to the Yangtze Valley of China, and was originally called "mihoutao" that is monkey peach in China and "Chinese gooseberry" in the rest of the world. When kiwifruit farmers in New Zealand decided to market the fruit overseas, they gave it the name "kiwi" to identify it better with New Zealand. The name "kiwi" (*Ateryx australis*) or "kiwifruit" comes from the kiwi, a flightless bird and New Zealand's national symbol, and also a colloquial name for the New Zealand people.

The genus Actinidia belongs to the Actinidiaceae. The four infra-generic sections in this genus are: Leiocarpae, Maculatae, Stellatae, and Strigosa. This classification is based on the characteristics of the fruit (presence or absence of lenticels), pith (lamellate or non-lamellate), and hair (simple or stellate). Although kiwifruit is now an important crop in many parts of the world, much fruit is collected each year from the wild in China. The most widely planted kiwifruit cultivar is the fuzzy kiwifruit A. deliciosa- 'Hayward'. 'Hayward' accounts for about half of kiwifruit cultivation throughout the world. 'Hayward' kiwifruit also represents about 90% to 95% of the kiwifruit traded internationally. The fuzzy kiwifruit A. deliciosa is commercially the most important crop and its total production accounts for about 1.8 million tons per year. However, internationally kiwifruit is a minor crop representing about 0.2% to 0.3% of total fresh fruit production. In terms of "marketable gross production" (essentially, crop value), kiwifruit is the sixth most valuable fruit crop after citrus, apples, table grapes, peaches/nectarines, and pears. (David *et al*., 2018)

It contains high levels of bioactive compounds such as vitamin C vitamin E, flavonoids, carotenoids and minerals. Kiwifruits show a wide diversity in size, shape, fuzziness, flesh and peel color and flavor. The species Actinidia deliciosa has a smooth, bronze skin, with a beak shape at the stem attachment. Flesh colour varies from bright green to a clear intense yellow. This species is sweeter and more aromatic in flavor. The yellow fruit fetches a higher market price and, being less hairy than the fuzzy kiwifruit, is more palatable for consumption without peeling. But it has a short storage life which limits its commercialization.

Kiwi fruit is a one of the multipurpose fruits and it has a lot of therapeutic benefits and applications, these therapeutic benefits it is used in dairy, food, chemical, pharmaceutical industries (Guroo *et al*., 2019).

History

Kiwi fruit is traditionally used for various treatments in Ayurveda. Ayurveda, the traditional scientific system of Indian It contains high levels of bioactive compounds such as vitamin C vitamin E, flavonoids, carotenoids and minerals. Worldwide evidences have been observed for its therapeutic action by many scientists. As per many scientists' Black plum contains various phytochemicals present in seeds and fruits which possess many therapeutic actions Antidiabetic, Antibacterial, Antioxidant, Antidiarrhea, Antihyperlipidemic, Free radical scavenging. Thus, this small fruit has lot of potential to be used as nutraceutical and therapeutic food

Year	Development	Scientist
12th C	1st recorded description – Kiwi Fruit dates	Song Dynasty
1700s	Species was first found at border of Yangtze River valley	Huang (China)
1750s	1st botanical specimens were sent to Europe	Jesuit priest
1847	1st plant sent for England and America	E.H. Wilson
1886	1st species was preserved in spirit in Kew, London	Robert fortune
1904	Introduction of Kiwi fruit to New Zealand	Isabel Fraser
1922	Listed kiwi plant as "a wonderful fruiting climber"	Hayward Wright
1960	kiwi was 1st planted in India	Bangalore
2005	Anticancer activity in kiwi fruits	Lippi
2009	Antioxidant activity in kiwi fruits	Park *et al.*,
2018	Kiwi fruit enzyme is replaced as rennet in cheese preparation	Sharma *et al.*,

Status of kiwi fruit

According to agriculture and processed foods export and development authority, China stands first in production of kiwi fruit of 2196.7 metric tons and major producer are New Zealand of 558.19MT, Italy of 524.49MT, Iran of 344.19MT, Greece of 285.86MT, Chile of 177.21MT. In India produce around 13000 tones and major producer are Arunachal Pradesh, Nagaland, Mizoram, Himachal Pradesh, Jammu and Kashmir. Percentage contribution for total production in India is Arunachal Pradesh of 56.83%, Nagaland of 22.92%, Mizoram of 9.58%, Himachal Pradesh of 3.19%, Jammu and Kashmir of 0.09% (APEDA, 2019).

Scientific classification of kiwi fruit

Domain	Eukarya
Kingdom	Plantae
Phylum	Magnoliophyta
Class	Magnoliopsida
Order	Ericales
Family	Actinidiaceae
Genus	Actinidia

Plant description

Kiwi fruit plant is borne on vigorous, woody, climbing shrubs or twinning vines. Height of the plant is 9 meters and plantation done at the time of January, Leaves are Deciduous, Alternate, and long petiolate and length of leaves is 7.5 to 12.5cms, Flowers are Fragrant, 5-6 petalled, white at first that changes to yellow, the best time to harvest is during September to October. Rate of Yield is for 3 year that is 4 tons per acre and for 8 year that is 25 tons per acre, yield rate per vine is 50-100 kg per vine.

VARIETY	CHARECTERISTIC
Abbott	The oblong, medium sized, fruits are covered with dense hairs. They are very sweet in taste Fruit weight of 45 - 50gms Ascorbic acid (50mg/100gm fruit) Yield of 12 kg/vine
Bruno	Medium sized with 60gm weight Completely cylindrical, dark drown with long and hard hairs Ascorbic acid - (50mg/100gm fruit) Yield of 29 kg/vine
Hayward	Most popular cultivar of the world, Large, ellipsoidal shape with 80gms weight Skin is brown with thin hair Ascorbic acid – (62mg/100gm fruit) Yield of 32kg/vine
Monty	Characteristic vertical striations have tendency to produce 3 fruits per peduncle Weights about 80 – 90gms Ascorbic acid of 70mg/100gm fruit Yield of 10kg/vine
Allison	Resembles to those of Abbott, except slightly broader in proportion to its length. Medium sized with 60 – 70 gms weight Ascorbic acid – 48mg/100gm fruit Yield of – 13kg / vine
Jing gold	Smaller in size with weight 40-45 gms. . It has yellow pulp and sweet in taste Ascorbic acid 45mg/100gm fruit Yield of – 10kg / vine

Kiwi fruit plant

Farmers put fruit or seed into the soil gently they water it often and kiwi requires lot of water because it is very moist fruit, there should be 200 square feet for a kiwi farm and There must be protection from wind and frost in order for kiwi fruit to grow. For kiwi plant soil pays important role that's why it requires deep rich well drained sandy loam soils. Annual rainfall requires of about 150 cm and temperature is less than 15°C.

Classification of kiwi fruit

Constituents	**Quantity (Gms/100gm Fruit)**
Moisture	83.1
Fat	0.52
Protein	1.14
Carbohydrate	14.7
Sugar	9.0
Ash	0.61
MINERALS (mg/100g)	
Potassium	312
Phosphorus	34
Calcium	34
Magnesium	17
VITAMINS (mg/100g)	
Vitamin C	92.7
Vitamin A	122µg
Vitamin K	40.3µg

Composition of kiwi fruit

(David *et al*., 2018)

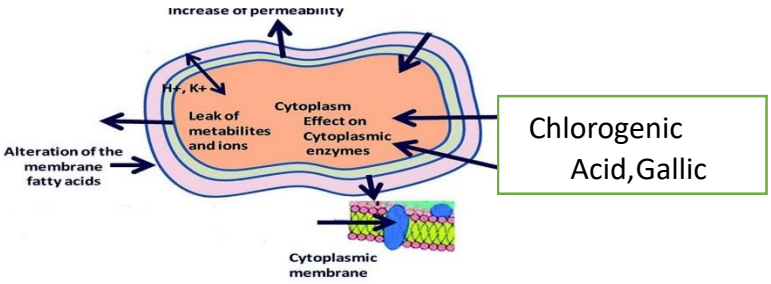
Therapeutic benefits of kiwi fruit

1. Anti-bacterial
2. Anti-cancer
3. Anti- diabetic

Antibacterial activity

Compound	Mechanism	Spectrum of activity
Phenolic compound (0.39g/100gm)-	Dissolves the fatty acids of cell membrane - increases cell permeability - leaking of cell constituents.	*Escherichia coli*
chlorogenic acid, gallic acid-		Staphylococcus aureus
Hydrophobic in nature		Listeria monocytogenes

Mechanism of action



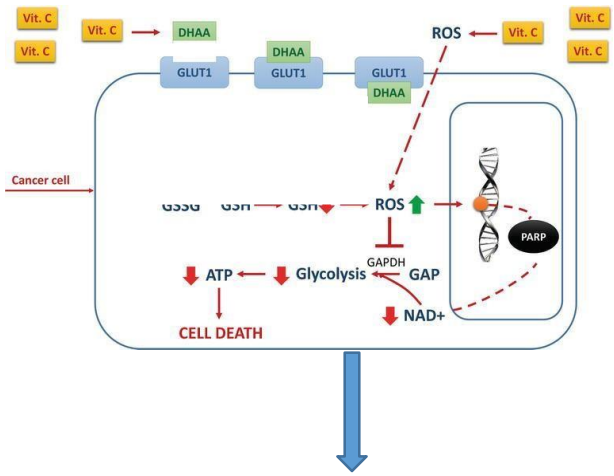
The sites or structures of the bacterial cell that are considered targets for action by the components of natural products. The action mechanisms of natural compounds are related to disintegration of cytoplasmic membrane, destabilization of the proton motive force (PMF), electron flow, active transport and coagulation of the cell content. Not all action mechanisms work on specific targets, and some sites may be affected due to other mechanisms. Important characteristics responsible for the antimicrobial action of phenolic compounds include hydrophobic components that allow the participation of lipids from the bacterial cell membrane, which disturbs cell structures and make them more permeable, changes the internal ph which significantly affects the cell membrane by dissolving the fatty acids and creates pores in the cell membrane and leaking of cell constituents occurs and finally leads to death of bacteria.

II. Anti-cancer activity

Active component	Activity
Vit. C (ascorbic acid) - 92.7mg /100g	ANTI CANCER act – ROS

Mechanism of action

High amounts of DHAA enter the cancer cells, thanks to the overexpressed GLUT-1 receptors. DHAA is then reduced again to vitamin C inside the cells. The reduction of DHAA to vitamin C scavenges



DHAA-Dehydroascorbicacid
ROS- Reactive oxygen species
PARP- Poly ADP ribose polymerase
GAP- Glyceraldehyde 3 phosphate
NAD- Nicotinamide adenine dinucleotide

glutathione (GSH), thus inducing redox imbalance and oxidative stress. Oxidative stress, in turn, leads to inactivation of GAPDH, vitamin C, functioning as a prooxidant, would induce an increase in the intracellular reactive oxygen species (ROS), which leads to increased DNA damage, with consequent activation of poly ADP-ribose polymerase (PARP), an enzyme necessary to repair damaged DNA. PARP activation would in turn consume NAD+, with NAD+ depletion and consequent ADP depletion inhibition of glycolysis, and energetic crisis, which leads to cancer cell death.

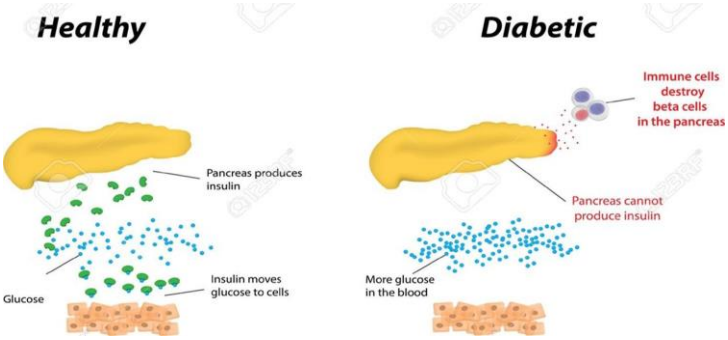
III. Antidiabetic activity

Active Compound	Mechanism
Zinc (0.14 mg/100gm) and Magnesium (17 mg/100gm)	Beta-cells of pancreas – improves production of insulin

Mechaism Of Action

Diabetes mellitus, a complex syndrome is characterized by the imbalance in blood glucose homeostasis leading to hyperglycemia (high blood glucose) and a series of secondary complications caused by an absolute or relative lack of insulin which moves glucose to cells.

Normally beta cells of pancreas release insulin which moves glucose to celss present in blood. But in case of diabetes, the destruction of pancreatic beta cells occurs which affect the release of insulin. So, glucose level increases in blood causing diabetes. Normally Streptozotocin selectively destroys pancreatic insulin secreting β-cells causing diabetes close to type-2 diabetes of humans. Streptozotocin induces a wide variety of animals species by damaging the insulin secreting pancreatic β-cells, resulting in a disease in endogenous insulin release, which paves the ways for the decreased utilization of glucose by the tissues.



Applications of kiwi fruit

Kiwi fruit enriched dahi ingredients:

Milk: 4.5% and 8.5% SNF

Sugar: 6%

Kiwi fruit juice:8%,10%,12%

Culture: 2%

Standardized milk (4.5% and 8.5% SNF)

↓

Heated to 90°C/5min & cooled to 30°C

↓

Addition of sugar (6%) & kiwi fruit juice (8,10 and 12%)

↓

Homogenization 65°C/ 2stage, 2500psi and 500psi

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Addition of Starter culture @ 2% (*Lactococcuslactis* ssp.*lactis*, *L. lactis* ssp *cremoris*, *L. lactis* ssp. *diacetylactis* along with *Leuconostoc* species.)

↓

Packaging and incubation (30°C / 10h)

↓

Cooling and storage (7°C)

Fresh sweet good quality standardized milk (4.5% and 8.5% SNF). The standardized milk was

heated to 90 °C for 30 minutes; it was cooled to 30 °C. Addition of sugar (6%) and kiwi fruit juice (8,10,12%). Homogenization is done at 65°C by two stage ,2500 and 500 psi and then inoculated by starter culture @ of 2% and incubated, at 30 °C for 8 to 10 hours until a firm coagulum (Dahi) was formed.

Sensory analysis of kiwi fruit enriched dahi

Parameter	Colour and appearance	Body and texture	Flavour	Overall acceptability
Control	8.33	8.33	8.50	8.50
Kiwi fruit (8%)	8.33	8.16	8.33	8.16
Kiwi fruit (10%)	8.66	8.50	8.66	8.60
Kiwi fruit (12%)	8.16	8.33	8.00	8.16

Result: Good quality, value added Dahi with more acceptability can be prepared by addition of Kiwi fruit juice. The treatment containing 10% Kiwi fruit juice was most acceptable in terms of sensory score however the treatment containing 8% & 12% Kiwi fruit juice also obtained satisfactory results as they were within the acceptable limit. (Nikhil, 2017).

Parameters	Appearance	Odor	Taste	Texture	Overall acceptability
Control	8.94	8.50	8.56	8.93	8.90
5% KFP	8.88	8.69	8.69	8.81	8.75
10% KFP	8.38	8.75	8.75	8.76	8.38
15% KFP	7.75	8.81	8.37	8.44	8.19
20% KFP	7.44	8.31	7.31	8.13	7.56

Development of biscuit with incorporation of kiwi fruit powder Ingredients:

Wheat flour :80g

Kiwi fruit powder: 20g Sugar: 35g

Sodium chloride:0.5g Baking powder:0.6g

kiwi fruit powder: wheat flour 5:95,10:90,15:85,20:80

↓

Sugar (35g), Butter(40g), Sodium chloride (0.5g), Baking powder (0.6g)

↓

Mixed in Moulinex mixer (2 min)

↓

Cookies dough was sheeted, cut into shapes

↓

Baking (170-180°C for 20 min)

↓

Packaging and storage

The formula used for cookies preparation [wheat flour and different proportion of kiwi fruit powder. The dough was made from 35g sugar, 40g butter, 0.5g sodium chloride, 0.6g baking powder and water using Moulinex mixer (model Super mix 150). Butter and sugar were creamed in a mixer for 2min at slow speed. Wheat flour containing various proportions of kiwi fruit powder with baking powder was added and mixed for 3 min at medium speed. The cookies dough was sheeted, cut and baked at 170-180°C for 20 min. The baked cookies were cooled at room temperature.

Sensory parameter of biscuit prepared from kiwi fruit powder

Cookies production by substitution with kiwi fruit powder which was considered as a good source of phytochemicals components like crude fibers, bioactive compounds and antioxidant activity. It could be concluded that substitution of wheat flour with kiwi fruit powder improved the antioxidant activity and nutritional quality with acceptable

sensory characteristics of produced cookies at 10 and 15% substitution level of kiwi fruit powder, respectively. So, it is possible to maximize the benefit of the kiwi fruit and its powder as a preferred functional product for consumers, especially children who like cookies. (Zahrat**, 2017**).

Future prospects

In future there is a need for further innovations in the manufacture of kiwi fruit products and there use in food products, perfect validation is need to imposed that gives a value addition to the products. Research and development is essential for effective utilization of the underutilized kiwi fruit and its by products in food industry and dairy industry because it have a good therapeutic benefits. Promotion and Commercialization need to be emphasized and Legal Standards need to be implemented for proper utilization kiwi fruit.

Conclusion

Kiwi fruit it is power house of nutritional components such as vit c, fiber, protein, minerals it helps provide good health to human. Scope for Value addition in dairy and food products that helps enhance of human health & increase the nutritional value. In dairy industry especially in cheese industry, the kiwi fruit enzyme is suitable alternative to rennet that helps to reduce the use of calf rennet. Greater awareness is needs to be created for better commercialization.

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