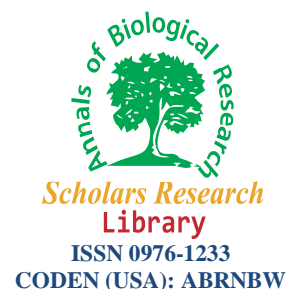




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***Malus domestica*-“The King of Delicious Fruits” booming in the *Paradise of Botanists* (Arunachal Pradesh)**

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ABSTRACT

Malus domestica belongs to rose family Rosaceae of Angiosperms. China is the world's largest producer of apples while India holds the second place in world trade market. The most common varieties of apples in India are Red Delicious and Granny Smith. In North West Hill Region, Jammu and Kashmir contributes 80% of India's apple production, Himachal Pradesh which is the second largest producer accounts for 12.5% and Uttarakhand produces 5% of India's apples. In North East Hill Region, Arunachal Pradesh is the only major apple producing state outside the north-western hill region in the country producing Black Bendavis, Royal gala, Jonathan, Red Gold, Gani Gala, Rich-A-Red, Royal delicious, Red delicious, Golden delicious, Cooper- IV, McIntosh, Crofton, Granny smith, Starkrimson, Fokla, Ruspippin, Rajakori, Ganu and Mutsu apple varieties. The apples are a great source of fiber and pectin, and helps in controlling insulin levels, acts as anti cancerous, anti cholesterol and reduce risk of asthma and diabetes. This paper will discuss the apple varieties of one of eight sister states of India, i.e.; Arunachal Pradesh.

Keywords: *Malus domestica*, Apple Varieties, Arunachal Pradesh

INTRODUCTION

Apples are discussed in the tradition and mythology of various cultures and apparently kept gods and goddesses immortal. King Arthur of British went to Avalon, “*Isle of Apples*” to live in a phenomenal paradise. Even the romantic King Solomon of the Bible mentioned apple, yearning to be “**comforted with apples,**” for he was “**sick with love.**” Although some correlate apple with India; the country's implausible geographic miscellany makes some states suitable for growth of delicious apple varieties. To trail the record of apples is to trail the account of mankind. Whilst the majority of historians hypothesize that it was pomegranate and not apple conscientious for man's disgrace in the Garden of Eden, apples are cited in humanity's most primitive recordings. Europeans are known to grow apple from the stone ages. The precise origin of apple gets bantered around between botanists. Some claim it's Switzerland or Scandinavia, but others more credibly point to the Caucus regions, specifically Kazakhstan. Another theory is that apples came from the ancient supercontinent of Laurasia. When it divided, North Americans had sour crab apple varieties while Central Asians were blessed with the larger and sweeter varieties. Apples originated in the Middle East more than 4000 years ago. The fruit arrived in England at the time of the Norman Conquest (1066) after spreading across Europe to France. Apples have been in India for centuries, though British like to credit their

introduction to India during their rule. N. Jayapalan in his book, “**Economic History of India**” states that the Muslim ruler Firoz Tughlaq grew apple trees all through Delhi neighborhoods during 1309 to 1388. British after their invasion centuries later, planted apple trees in the north, however, locals did not like those crabapple because of their sour taste. However, in early 1900s Samuel Evans Stokes of Philadelphia came to India along with seeds from ‘Sweet’ apple variants which were accepted by farmers of Himachal Pradesh leading to blow up of country’s apple industry. Apple was introduced in India by the British in the Kullu Valley of Himachal Pradesh in 1865, whereas the ‘Delicious’ cultivars of apple were brought to Shimla hills of H.P. in 1917. The apple cultivar ‘Ambri’ is indigenous to Kashmir and was growing prior to Western introductions [1].

The area under apple cultivation in India improved by 24% from 1.95 lakh hectares in 1991-92 to 2.42 lakh hectares. In 2001-02 production augmented by < 1%. In India it is generally grown in Jammu & Kashmir, Himachal Pradesh, Uttaranchal, Arunachal Pradesh and Nagaland. In 2011-2012, roughly 80% of India’s apple production is from Jammu and Kashmir with 1.8 million tons. Himachal Pradesh is the second largest producer with 12.5% of India’s production amounting to 275,000 tons. Uttarkhand produces 5% of India’s apples and stands at distant third. Other states producing insignificant amount of the country’s supply are Uttar Pradesh, Arunachal Pradesh, Uttaranchal, Sikkim, Nagaland and the colder hill stations of Tamil Nadu. According to UN’s Food and Agriculture Organization (2011), India is the third largest grower of apples in the world accounting for 4 % of the global produce. However, China produces about half of the world’s apple supply.

S. No.	Crop	2000- 2001		2001- 2002		2002- 2003		2003- 2004		2004- 2005	
	Fruit	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
1.	Apple	6733	8513	6867	9364	6972	9694	7320	10178	7686	10687
S. No.	Crop	2005- 2006		2006- 2007		2007- 2008		2008- 2009		2009- 2010	
	Fruit	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.	Area	Prod.
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Arunachal Pradesh commonly known as the *Land of Rising Sun* or the *Paradise of the Botanists* is positioned on the eastern most corner of India sharing international borders with Bhutan, China and Burma. It is the largest state among all the north eastern states of India. The state of Arunachal Pradesh lies between the North latitude of 26028' to 29030' and East longitude of 90030' to 97030' with total geographical area of 83743 sq km and population density over 17. According to Census of India (2011), the total state population is 1, 382,611 of which 64% is tribal population, wherein the size of rural population is 10, 69,165 (77.33%) and the urban population is 3, 13, 446 (22.67%). Majority of land of Arunachal Pradesh comes under the Himalayan and Patkai ranges of mountains with altitude ranging from 60 meters upto 7300 meters while the total cultivable area under Jhum/shifting cultivation was 1.10 lakh hectares and under permanent cultivation was only 0.90 lakh hectares. Most of the cultivable areas are rain fed with heavy to moderate rainfall ranging from 164 mm to 5600 mm. Arunachal Pradesh is rising as a major apple-growing state in the north-east, with 8,400 ha under apple cultivation with produce of 9,500 tones. Its productivity is 1.1 tones/hectare which can be increased manifold by the interventions of high yielding spur type cultivars (Scarlet Spur, Oregon Spur, Red Fuji, Idared, Liberty) and appropriate pollinizers (Golden Delicious, Gold Spur, Red Gold). The growing belts of apple in Arunachal Pradesh are Tawang, West Kanneng, and Lower Subansiri. The districts of West Kameng and Tawang have the largest area under production of apple followed by Lower Subansiri, West Siang and East Kameng.

<i>Apple production in Arunachal Pradesh</i>				
S.NO.	Year	Area (ha)	Production (MT)	Yield (MT/ha)
1	1991-92	5100	9300	1.82
2	1992-93	5336	9720	1.82
3	1993-94	5523	9730	1.76
4	1994-95	5709	9250	1.62
5	1995-96	5970	12993	2.18
6	1996-97	6186	14500	2.34
7	1997-98	6370	15225	2.39
8	1998-99	6477	15986	2.47
9	1999-00	6601	8265	1.25
10	2000-01	6733	8513	1.26
11	2001-02	6852	8588	1.25

Commercially grown apple varieties are syrupy, luscious with a pleasant grainy texture akin to drier pear varieties. The particular balance of sugariness, granularity in quality and sturdiness in savor depends on the variety, which may be categorized into 4 major types:

<i>District-wise apple production in Arunachal Pradesh</i>			
S.NO.	District	Total Area (ha)	Production (MT)
1	West Kameng	575.00	131.00
2	Tawang	84.12	43.66
3	Lower Subansiri	16.67	19.50
4	Upper Dibang Valley	10.00	Negligible
5	Total	685.79	194.16

1. **Green apple varieties:** These are crisp, rigid and have a good munch with tang a blend of saccharine, bitter and sour. These have spicy sour “bite” and bear semblance to the taste of wild apples. Green apple varieties are best only when raw or roasted.

2. **Pink apple varieties:** These varieties should have crunchy texture, compact and principally saccharine with a trivial hint of acidity. Pink apples have sour annotations of green apples but are habitually pleasurable in their sweetness. These are best when raw as salads and slow baked.

3. **Golden apple varieties:** These varieties are luscious, crunchy, flexible and have softer texture with a placid and sweet taste which is idyllic as pies, salads and applesauce.

4. **Red apple variety:** These varieties are not as brittle or firm like other varieties. These are sweetest and least acidic and have grainy texture and the fleshy tissue is not firmly packed. In conjunction with golden apples, red apples have the mellowest savor.

The important apple varieties cultivated in different states of India are listed below:

S.NO.	Category	Varieties
1	Clonal rootstocks	M 9, M 26, M7, MM 106, MM 11
2	Scab resistant	Prima, Priscilla, Sir Prize, Jonafree, Florina, Macfree, Nova Easy Grow, Coop 12, Coop 13 (Redfree), Nova Mac, Liberty, Freedom, Firdous, Shireen
3	Hybrids	Lal Ambri (Red Delicious x Ambri), Sunehari (Ambri x Golden Delicious), Chaubattia Princess, Chaubattia Anupam (Early Shanburry x Red Delicious), Ambred (Red Delicious x Ambri), Ambrich (Richard x Ambri), Ambroyal (Starking Delicious x Ambri)
4	Low Chilling	Michal, Schlomit, Anna, Tamma, Vered, Neomi, Tropical Beauty, Parlin’s Beauty
5	Pollinizing	Tydemans Early, Red Gold, Golden Delicious, Mc Intosh, Lord Lambourne, Winter Banana, Granny Smith, Starkspur Golden, Golden Spur

The common varieties and new hybrids developed recently and grown in Arunachal Pradesh are discussed below:

1. **Black Bendavis** is popular commercial apple, perhaps originated in USA during the 19th and early 20th century. Because of its ruggedness and keeping qualities it is known as mortgage lifter [2].

2. **Royal gala** is dark red exotic (often imported) variety from New Zealand. Many sports including the popular **Royal Gala** have been selected for augmented red color. It was invented by Ten Hove (1977), marketed as Royal Gala, Tenroy and is mutated from Gala³⁶³⁷ with standard habit and stripe pattern. The fruit of this variety exhibits an attractive appearance and unlike the parent variety possesses an all over bright red color overlaid with obscure darker broad striping.

3. **Jonathan** is an old American apple variety discovered in 1820s and introduced to the market in 1864. This variety is spicy, juicy, fragrant, sweet-tart, good for cooking except when cooked whole and is excellent for snacks. It can be stored in the refrigerator for 120 days.

4. **Red Gold** is a variety of *Malus domestica* from the United States produced as a cross hybridization between Golden Delicious and Red Delicious, *i.e.* why named as Red Gold. It was developed in Cashmere, Washington and has a height of 30 feet with pink and white flowers. Red Gold apples are accessible in the early fall through the winter months. Apples have small- to medium-sized oblong fruit with glossy deep red skin over a gold milieu. The flesh is luscious; light yellow, more sugary than most varieties, rich in Vitamin C, Vitamin E, Vitamin K, Vitamin A and dietary fiber and can be stored in refrigerator for many weeks. Red Gold avers to be the sweetest apple in the

market, so this apple is great for those who like sweet fruit exclusive of any tangy notes. These are good for eating fresh, as apple sauce, for cider preparation and are part of a long Washington state apple tradition.

5. **Gani Gala** is clonally propagated apple cultivar, vertically striped or mottled, overall orange in color and originated from New Zealand. It has pinkish stripes over a yellow backdrop. Gala apples are sweet, fine textured, aromatic, can be added to salads, cooked, excellent for snacks, sauces and pies and are available from September to May.

6. **Rich-A-Red** is a variety of bright red-flushed apple. It is a **Sport** (Natural genetic mutation) of **Delicious** discovered in Monitor, Washington United States [3], introduced commercially in year 1926 and trademarked by C & O Nursery Company. Fruits have very firm, sweet, juicy flesh with an aromatic flavor. This late-season variety is harvested from early October in South-East England and is at its best from December to March. Rich-A-Red is only fair color (blush), but better tasting than most modern strains. Flavor is rich and complex, with hint of coconut. Fruit and tree is indistinguishable from Delicious except fruit being attractive light cherry red, bloated in shape, colors earlier and darker [4].

7. **Royal delicious**

8. **Red delicious:** The red delicious originated at an orchard in 1880 and was originally called the “Hawkeye” before Stark Brother Nurseries procured the rights and changed its name [5]. It is sweet, juicy, good for eating fresh, as salads but not good for baking. It has rich red color occasionally striped with yellow. It is a mid-season apple grown in Arunachal Pradesh, available from August to November. This variant along with Royal Delicious is the most extensively grown apple variety in India. The antioxidant quercetin is especially found in red delicious apples which boost immune system to build the natural defenses of the body mainly in stress conditions [6].

9. **Cooper- IV** is one of different varieties of apple grafts.

10. **McIntosh:** This apple was discovered by John McIntosh on his Dundela farm in Ontario, Upper Canada (1811). **Mac** is an apple cultivar and national apple of Canada. It is a reddish pink apple with a golden blush grown in Uttar Pradesh, Arunachal Pradesh and Himachal Pradesh. It is a small- to medium-sized round fruit with white flesh sometimes tinged with green or pink with thick, juicy, tender firm, soon becoming soft and easy to peel. This brilliant green variety of apple is sweet with just traces of tartness. The flesh is easily bruised [7]. It is a favorite in lunchbox, excellent for snacks, sauces, most preferred choice for making pies and salads and as baking or freezing apple.

11. **Crofton:** The Crofton apple variety originated in Hobart, Tasmania (1870). It is related to Fame use or Snow Apple and was once grown commercially in Australia. Small to medium flattish, yellow-green with red blush, flesh very white, crisp, sweet and ripens mid season. It has arisen from Red Delicious, Yellow Delicious and Winter Banana wherein pollinator is Jonathan. It has shape of Red Delicious, character of Yellow Delicious, Yellowish Green skin with a beautiful distinctive reddish pink blush and has mildly sweet flesh. It is good for fresh eating, cooking, freezing or drying.

12. **Granny smith:** The Granny Smith cultivar originated in New South Wales, Australia (1868), grown from seeds thrown out by chance by Mrs. Thomas (Granny) Smith. It is considered as a hybrid of *Malus sylvestris*, wild apple with the domestic apple *M. domestica* as the polleniser. It is sweet, crisp, eaten raw, used in snacking, salads, sauces, freezing and pie baking [8]. It produces fairly low levels of ethylene which contribute to its long storage life and can be stored without loss of quality for a year. This cultivar needs fewer winter chill hours and a longer season for fruit maturation, so is favored for the milder areas of the apple growing regions but is susceptible to superficial scald and bitter pit. It is an efficient source of antioxidants, particularly flavonoids, cyanidin and epicatechin, mainly if eaten with the skin intact and has highest concentration of phenols amongst the apple breeds [9]. Granny Smiths are also naturally low in calories and high in dietary fiber and potassium, making them commonly recommended as a component of healthy and weight-loss diets [7].

13. **Starkrimson** belongs to Spur types of apple.

14. **Fokla**

15. **Ruspippin**

16. *Rajakori*

17. **Golden delicious:** Golden delicious is developed by Anderson Mullins in West Virginia, United States (1890) and was locally known as Mullin's Yellow Seedling and Annit apple. Anderson Mullins sold the tree and propagation rights to Stark Brothers Nurseries, which first marketed it as a companion of their Red Delicious in 1914 [10]. The Golden Delicious was designated as the official state fruit of West Virginia by a Senate resolution on 20th February, 1995 [11]. It is a chance seedling, hybrid of Grimes Golden and Golden Reinette [12] and a late-season cultivar grown in Jammu and Kashmir, Himachal Pradesh and Arunachal Pradesh. The **Golden Delicious** is a cultivar of apple with a yellow color, sweet with a silky texture and crisp thin skin [10]. It is yellowish-green skinned cultivar, sometimes with a bright pink blush if cool nights precede harvest and is one of the 15 most popular apple cultivars in the United States. These apples are excellent for pies, sauce, apple butter, baking and fresh eating. Bruising and shriveling can occur, so it needs care while handling and storage. The complete genome of the Golden delicious apple was decoded in 2010 by an Italian-led consortium [13] which reported highest number of genes (57,000) of any plant genome studied to date. The United States Postal Service in 2013 issued a set of four 33¢ stamps in honor of some apples including the 'Golden Delicious' [14].

18. *Ganu*

19. **Mutsu:** The **Mutsu** apple (also known as Crispin) was introduced in 1948. It is result of a cross hybridization between Golden Delicious and Indo apple varieties first grown in Japan and named after the Mutsu Province of Japan. 'Mutsu' is a triploid cultivar and is exceedingly disposed to the Blister Spot disease.

Health Benefits of Apples:

Apple has a number of traditional uses along with scientifically validated health benefits. According to the "Encyclopedia of Folk Medicine," the British used to rub apples on warts. The fruit's high fiber content makes it a long-standing therapy for constipation and other stomach complaints. Rotten apples can treat topical ailments like sore eyes, weak eyes and blisters. In Cambridge shire, the belief was that keeping an apple in the room of a smallpox patient would transfer the incapacitating infirmity from the patient to the fruit. The apple peel has strong anticancer activities when tested on human breast cancer cells, liver cancer cells, and colon cancer cells [15]. The apple peel compounds display antihypertensive properties against high blood pressure [16]. The lifespan increased by 10% in apple-eating test animal group and showed fewer signs of age-related illnesses [17]. Apples contain an anti-inflammatory compound which suppress T-cell activation and can be helpful in bowel inflammatory disorders such as Chron's disease, ulcerative colitis and colon cancer [18]. According to USDA Nutrient Database, 100g of apple have the following values: For perspective, one medium apple weighs 182g.

S.NO.	Energy	52kcal
1	Carbohydrates	13.8g
2	Fiber	2.4g (10% RDI)
3	Fat	.2g (neg)
4	Protein	.3g (1% RDI)
5	Vitamin A	54IU (1% RDI)
6	Vitamin C	4.6mg (8% RDI)
7	Vitamin E	.2mg (1% RDI)
8	Vitamin K	2.2mcg (3% RDI)
9	Thiamin	(1% RDI)
10	Riboflavin	(2% RDI)
11	Vitamin B6	(2% RDI)
12	Folate	3mcg (1% RDI)
13	Pantothenic Acid	.1mg (1% RDI)
14	Calcium	6mg (1% RDI)
15	Iron	.1mg (1% RDI)
16	Magnesium	5mg (1% RDI)
17	Phosphorous	11mg (1% RDI)
18	Potassium	107mg (3% RDI)
19	Copper	(1% RDI)
20	Manganese	(2% RDI)

CONCLUSION

More than 700 apple accessions introduced from USA, Russia, U.K., Canada, Germany, Israel, Netherlands, Australia, Switzerland, Italy and Denmark have been tried and tested during the last 50 years in India. The delicious

group of cultivars predominate the apple market with the areas under Delicious cultivars are 83% of the area under apple in H.P., 45% in J&K and 30% in U.P. hills. Recently it has been found that improved spur types and standard color mutants with 20-50% elevated yield output are favored in Indian conditions. The important selections are:

- **Spur types** - Red spur, Starkrimson, Golden spur, Red Chief and Oregon spur
- **Color mutants** - Vance Delicious, Top Red, Skyline Supreme
- **Low chilling cultivars** - Michal, Schlomit
- **Early cultivars** - Benoni, Irish Peach, Early Shanburry, Fanny
- **Juice making cultivars** - Lord Lambourne, Granny Smith, Allington Pippin
- **Scab resistant cultivars** - Co-Op-12, Florina, Firdous, Shirean
- **New Hybrids** - Lal Ambri (Red Delicious X Ambri), Sunehari (Ambri X Golden Delicious), Amred (Red Delicious X Ambri), Chaubatia Anupam & Chaubatia Princess (Early Shanberry X Red Delicious) developed in India.

In addition to above varieties, the varieties like Black Bendavis, Royal gala, Jonathan, Red Gold, Gani Gala, Rich-A-Red, Royal delicious, Red delicious, Golden delicious, Cooper- IV, McIntosh, Crofton, Granny smith, Starkrimson, Fokla, Ruspippin, Rajakori, Ganu and Mutsu are favorable for the climate of Arunachal Pradesh.

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