



# Sustainable Waste Utilisation and Viable Products from Coffee Cherry

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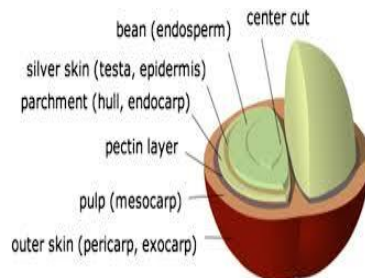
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**Abstract:** Coffee is one of the most consumed beverages in the world and India plays a major role in production and export of coffee. During coffee processing, coffee beans that are used for making fine coffee powder is removed from the entire coffee fruit eliminating some parts including husk, cherry, silver skin. Among those by products that are eliminated during the process, coffee cherries are major unutilized part. Waste management is one of the key factors in sustainable processing of food products to reduce environment pollution and also to use them effectively in other products. Considering these factors, the products made from coffee cherries include fertilizer, powder, beverage made from coffee berry skin etc. However, owing to the high nutritional content of edible coffee cherry such as polyphenols, antioxidant properties, it can be a good energy source when added to our diet. So, these can be wisely used in many processed foods to increase its overall nutritive value.

**Index Terms - Coffee cherry, antioxidant properties, health benefits, by-products, waste utilization.**

## I. INTRODUCTION

Coffee is one of the most widely consumed primary goods on the planet. Coffee is consumed by an estimated 125 million people on a daily basis throughout the world, with more than 50 countries producing and exporting coffee (1). For coffee production, India is Asia's third largest producer and exporter. *C. arabica* L. (*Arabica coffee*) and *C. canephora* A. *Froehner* are two of the most important species in the coffee industry (*robusta coffee*). *C. arabica* has been linked to high-quality drinks (2). Because coffee arabica is a self-fertile tetraploid, its large crop has very little genetic variability. Robusta has a relative humidity of 70 to 75 percent, while Arabica has a relative humidity of 60 percent. Skin, pulp, mucilage, and parchment make up roughly 40-45 percent of the waste produced by coffee manufacturing. Coffee silver skin is made up of the tegument of coffee beans and has a very low mass, accounting for only 4.2 percent of the green coffee bean's mass. It is high in soluble dietary fibre (54 percent of total dietary fibre) and antioxidant compounds, particularly phenolic compounds, and has a low environmental impact. Due to health benefits of coffee cherries (Fig. 1), it can be used as value added products which can improve the overall nutritive value of the product.



**Fig. 1** Coffee Cherry

**NUTRITIONAL VALUES OF COFFEE CHERRIES****COFFEE HUSK:**

Carbohydrate	58-85%
Protein	8-11%
Lipids	0.5-3%
Minerals	3-7%
Caffeine	1%
Chlorogenic acid	2.5%
Tannins	5%

**COFFEE PULP:**

Carbohydrate	21-32%
Proteins	5-15%
Lipids	2-7%
Minerals	9%
Tannins	1.8-8.56%
Caffeine	1.3%
Pectic compounds	6.5%
Chlorogenic acid	2.6%
Caffeic acid	1.6%

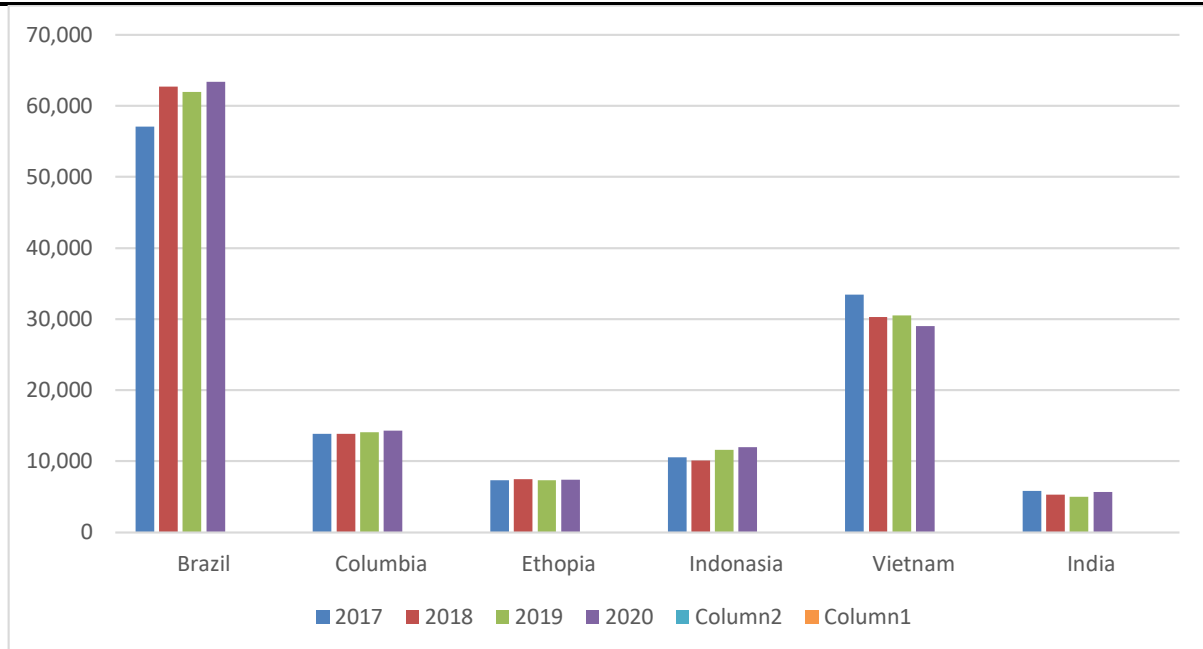
**II.COFFEE:**

Coffee is one of the most consumed beverages, that people consume it two to three times a day. Coffee belongs to family *Rubacea* and genus *Coffea*. There are two main types of coffee beans namely, *C arabica* (*Coffea arabica*) and *C robusta* (*Coffea canephora*). Some leading producers of coffee are Brazil, Vietnam, Indonesia, Columbia. It has very pleasing flavour and gives a refreshment when it is consumed. Studies say that, when coffee is consumed it gives a stimulatory effect on human body due to the presence of adenosine (3). And this can make a person swifter and more energetic. Caffeine is the major component that is present in coffee which stimulates the central nervous system. An approximate amount of caffeine content in coffee varies from 30mg to 175mg in 150ml cup of coffee (4). Coffee also contains other nutrients including Cafestol, kahweol, some micronutrients like magnesium, potassium, niacin, vitamin E and chlorogenic acid (a major antioxidant) (3). Consumption of recommended amount of coffee can also have good health effects like reduce the risk of developing type 2 diabetes, Parkinson disease, cardiovascular problems (5).

Coffee Arabica was first originated and cultivated in *Ethiopia* like other crops including durum wheat, barley and some millets. It was grown in different lands and was termed to be forest coffee, Garden coffee, semi- forest coffee (6). Since it was grown naturally in Ethiopia, those coffee was said to be organic coffee because they do not require additional brace like pests' control, fertilizers, etc (7). Lately in fifteenth century it was consumed as a drink, but earlier the people used it for medicinal purpose and also added them in cooking as one of the spices.

Coffee grows in high tropic region at the altitude 1300-2000m above the sea level with humid climate and requires moderate to heavy rainfall (1). Coffee plant takes five years for the first yield and it can last for about fifteen years. *Arabica* coffee plant are small tree that can grow up to 9-12m height.

And nowadays, it the most traded commodity and more than 50% of the countries are involved in production and export of coffee (1). The demand for coffee has also increased over the year. The coffee beans are collected and coffee beans are processed to get fine coffee grains that is especially used to make beverage. Coffee was first cultivated in Chikmangalur, state of Karnataka (9). And East Indian Company was responsible for establishment of coffee estates in India. Brazil is the 1<sup>st</sup> leading producer of coffee and it is said to be because of their latest technologies like mechanical harvester and they naturally have high productivity due to their climatic conditions. India is the 7<sup>th</sup> leading producer of coffee and important states that contribute for production are Tamil Nadu, Kerala and Karnataka (10). And India's climatic variation favours the cultivation of both *Arabica* and *Robusta* (9). Coffee production based on supply-demand for top 6 coffee producing countries are given in the graph 1, based on the statistics table of ICO (International Coffee Organisation).

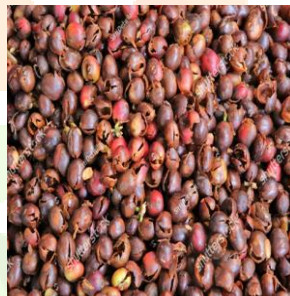


**Graph 1.** Coffee production in different countries from the year 2017-2020

### III. CURRENT UTILIZATION OF COFFEE BY-PRODUCTS

#### 3.1 COFFEE PULP

The first by-product obtained from the wet phase in coffee processing is coffee pulp (Fig. 2). It accounts for 29 percent of the dry weight of the whole cherry, and every two ton of coffee generates one ton of discarded coffee pulp. It's been employed as a biofertilizer, biological control agent, animal feed concentrate, human nutrition product, and other bioproducts and bioenergy sources.



**Fig. 2** Coffee cherry pulp

#### 3.2 COFFEE PULP IN AGRICULTURE:

Earthworms and different microbes are commonly used to make fertilizer. A study was conducted, and it was discovered that using coffee pulp as a substrate improved the growth and reproduction of *P. corethrurus* and *Amyntas cortices*. By computer methodologies, studies demonstrate that incorporating coffee pulp in fertilizers enhances soil quality. It covers mycorrhizals (12), soil treatment cycles management and phytoremediation) (12). Plants, biomass, humic acids, and polymerization were found to boost the growth and production of treated soil and plants. Overall, soil fertility and quality have improved, as has the efficient immobilization of Zn (87-91%), Cd (70-83%), and Pb (35-50%) polluted land (13).

Trichoderma spp distribution in soil is also improved when organic fertilizer is mixed with coffee pulp. Trichoderma spp. are biological control agents used in soil to manage plant diseases. The use of pulp fertilizer has also been reported to minimize nematode (*Tylenchuhus semipenetrans*) infestation (13).

#### 3.3 COFFEE PULP IN FOOD:

One of the most common uses for coffee processing waste, particularly coffee pulp, is animal feed. It's prepared by fermenting coffee pulp, which boosts the nutritious content. Feeding efficiency in hens was enhanced when they were supplied with a 10% fermented coffee pulp product, and fermented coffee pulp has also been used to boost their nutritional content (silage). For example, SSF with *Streptomyces* enhances protein content, while SSF with *Aspergillus Niger* increases total amino acid content (14). Coffee pulp addition of up to 25 g/kg of feed is recommended for these birds (14).

Bio-composition is widely recognized as the most cost-effective and environmentally friendly method for growing edible mushrooms. According to the study, coffee pulp was used as a substrate for edible mushrooms (*Pleurotus* spp., *Auricularia* spp., and *Volvariella volvacea*) to boost their biological efficiency and unsaturated fatty acids (oleic acid and linolenic acid) (14). Composting

is one of the most cost-effective and environmentally friendly methods for growing edible fungus; yet, one of the current limitations is the presence of unpleasant odours (14).

### 3.4 COFFEE HUSK

Coffee cherry husks are obtained from the dry processing of coffee berries. The coffee husk (Fig. 2) encases the beans and accounts for around 12% of the dry weight of the fruit. From 1 tons of coffee fruits, 0.18 tons of husk is generated (15). The moisture content of coffee husk is 15.0 percent, the ash content is 5.4 percent, the protein content is 7.0 percent, the lipid content is 0.3 percent, and the carbs content is 72.3 percent (15). 24.5 percent cellulose, 29.7% hemicelluloses, 23.77 percent lignin, and 6.2 percent ash are found in coffee husk.



Fig.3 Coffee Husk

As a result, polyethylene-coffee husk eco-composites for value-added consumer items are developed. Braskem supplied high-density polyethylene (HDPE, SGF4950 extrusion grade) and low-density polyethylene (LDPE, PB208 injection grade) (Brazil). CH were taken from coffee plantations in the Andes region of Colombia's Antioquia province. Some useful material parameters for composites processing and formulation, such as density and melt flow index, are listed in the study (MFI) (15).

### 3.5 COFFEE SILVER SKIN

Coffee silver skin is a coffee bean integument that forms as a result of the roasting process. It is a residue with a high concentration of soluble dietary fiber (86 percent of total dietary fibers) and high antioxidant activity, owing to the high concentration of phenolic compounds as well as the presence of other Maillard reaction products such as melanoidins after roasting cellulose and hemicellulose are the major components of other fibrous tissues. Coffee silver skin contains monosaccharides such as glucose, xylose, galactose, mannose, and arabinose, as well as proteins (16).

Coffee silver skin (Fig. 3), a key by-product of coffee roasting, is being employed as a fuel and soil fertilizer. Several studies have found that silver skin is a good source of bioactive chemicals that may be isolated and used in the cosmetic business. The synergistic interplay of chlorogenic acids (1-6%), caffeine (0.8-1.25%), and melanoidins (17-23%), among other antioxidant chemicals, may account for its strong antioxidant capacity (16).



Fig. 4 Coffee Silver Skin

## IV. VIABLE PRODUCTS

### 4.1 ENERGY MIX

The energy mix is the multigrain powder which is combined and bounded with the large number of nutritional value and that can be consumed by the people in all age group. As the coffee cherry is also contains different nutritional value like fiber, caffeine, carbs etc. Adding coffee by product to the energy mix may enhance the flavor to the mix and make the mix much healthier.

### 4.2 TEA BAG

A tea bag is a small porous sachet containing tea leaves and tea powders it can be used to make tea instantly. Tea bag is very useful product during travelling. Coffee by-products like coffee cherry or other products which contains the caffeine content can be filled in tea bag and it can be consumed by the people.



### 4.3 CHOCOLATE

Chocolate is a carving food mostly consumed by kids in large number. It is made from roasted and grounded cocoa pods and that is available as a liquid, solid or paste, on its own or as a flavoring agent in other foods. Coffee simply enhances the flavor of chocolate. In this cake, it deepens that rich, chocolaty flavor.

### 4.4 SPREADS

Spreads are added as food to enhance the flavor or texture of the food, which may be considered bland without it. Peanut butter, butter and cheeses are typical spreads. It is mostly used in breakfast. Adding coffee by-product in spreads will enhance the new flavor and it will give us a healthy breakfast.

### 4.5 ENERGY BAR

Energy bars may contain enough nutrients to be used as meal replacements if they are manufactured properly. Because most energy bars have extra protein, carbs, dietary fiber, and other nutrients, they may be advertised as functional foods.

## V. CONCLUSION

As there is increase in coffee production, the equal amount of coffee waste is also produced. Large amount of solid waste produced during coffee processing majorly cause pollution. Usually, these by-products with unutilized nutrient contents are discarded. These by-products which is used as fertilizers, animal feed, cascara tea can also be used in other products to enhance the overall nutrient value. Due to its chemical compounds like polyphenols, chlorogenic acid and other anti-oxidants, the food products that is added with coffee cherry wastes can enhance the overall health benefits. Sustainable production of food products by minimizing the waste production in industry is considered as important. So, industries focus on reusing the discarded products as raw materials for new products. The edible coffee cherries can be highly beneficial when it is added in food product. Due to its chemical compounds like polyphenols, chlorogenic acid and other anti-oxidants, the food products that is added with coffee cherry wastes can enhance the overall health benefits. Alternate use of cherry waste also plays a vital role in waste management. The review paper also includes the various possible products of the coffee cherry wastes.

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