Chapter

Vigna unguiculata (L.) Walp: A Strategic Crop for Nutritional Security, Well Being and Environmental Protection

M. Duraipandian, K.E. Poorani, H. Abirami and M.B. Anusha

Abstract

Cowpea is the common legume crop plant widely cultivated in all over the world for human consumption and animal feed. The global biological name of cowpea is *Vigna unguiculta* (L.) Walp. The crop is cultivated globally in all warm-seasons, semiarid or specifically tropical regions by even poor farmers but originated from anciently to Africa. Cowpea able to grow in even variety of polluted soils and able to grow vigorously withstand in both biotic and abiotic stress conditions. Morphologically herbaceous dicotyledonous plant, grow annually. The entire plant parts of *Vigna unguiculata* (L) Walp such as dry seeds, leaves, roots and pods consumed by all humans and animals Cowpea has rich in nutrition, vitamins and minerals so preferred by many farmers cultivated as intercrop with other cereals. In this review able to discuss the nutritional, medicinal as well as ecological significance. The seeds of cowpea have high content of proteins, fiber foods like carbohydrates, low cholesterol, minerals and vitamins. The nutrient value is higher and delay hungry sense in cowpea when compare to other cereals or pulses. The cowpea used for various medical aspects to lower cholesterol, promote body growth, iron source to increase blood cells, improve gall bladder function, maintain good circulatory system, increase insulin production, decrease body weight and do excellent antioxidant mechanism. The black eye pea also maintains good health to reduce both communicable and non-communicable diseases. Cowpea to form symbioses with variety of beneficial soil microorganisms to increase soil fertility, soil-root aeration, improve humidity and do fix atmospheric nitrogen to reduce global warming, climate change and also increase activity of biogeochemical cycle in the environment. In future people focus on to cultivate cowpea with to increase global production in all countries.

Keywords: legume, tropical, biotic & abiotic, intercrop, nutrition, Fiber food, Symbiosis and biogeochemical cycle

1. Introduction

Legumes are third largest family of flowering plants which consist of over 20,000 species, under the family of Fabaceae, amoung them *Vigna unguiculata* (L.)

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Walp is an annual, herbaceous, commonly cultivated throughout the landscape of the earth, with high values in its nutrients, medicinal value and also helps in ecological balances. This crop is cultivated worldwide. The cultivar group such as *Sesquipedal* is wildly known as long or sneak or asparagus bean with have sixteen ovules present and the seeds arranged within the pod compactly and it is suggested as a sub species in Ref. with molecular level [1].

It is an important crop in the semiarid regions across India, Africa and Russia, naturally it is the farmers friendly crop due to crop survival, yield, resistance towards pest, tolerance in sandy soil, low rainfall, whole plant is used as cattle feed and also well-suited to intercropping with other crops as the plant fixes nitrogen with *Agrobacterium*.

There are many species can exist but the common sub-species are includes as *V. unguiculata, Viola biflora, V. textilis and V. Sesquipedalis* are recognized. Among the subspecies, the *V. unguiculata, V. biflora* and *V. textilis* are cultivated worldwide. The bean plants have more morphological difference and found in same species with high differences in the shape, structure and size, shape, and structure. Cowpeas are growing by in semi-erect, erect and climbing manner.

The bean crop is cultivated for the purpose of cattle feed and its seeds have high nutrient values, in terms of rich protein, carbohydrates, vitamins and minerals. The cow pea plant green stems and leaves and seed coats are high nutrients, so consider as cattle feed which increase cattle milk production for many application for in the dairy industry. Many varieties cowpeas were traditionally cultivated in some states India, but in Africa consider as primary cultivar. The countries such as United States of America, United Kingdom, Europe and some parts of Asia.

The cowpea was emerging crop for food and Nigeria considered as largest production country approximately 3.67 million tons and the second largest cultivar Niger global production of cowpea are approximately 2.6 million tons and other countries cowpea production is approximately 2 million tons in 2020. The production of cowpea is marginally reduced in globally approximately 8.2 million tons in 2020. Cow pea seeds are usually cooked and made into stews and curries, or ground into flour or paste.

Most cowpeas are grown on the African continent, particularly in Nigeria and Niger and also in India which account for 66% of world production. Recently the estimate suggests that cowpeas are cultivated on 12.5 million hectares of land. The cowpea has been cultivated in tons of three million and two hundred million humans consume in everyday. The large number of production of cowpea in many places should drastically reduction by the involvement of many pests and insects, particularly causing over ninety percentage loss in crop yield.

2. Taxonomy of cowpea

Kingdom	Plantae
Sub kingdom	Trcheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Sub class	Rosidae
Order	Rosales

Family	*Fabaceae*
Genus	*Vigna*
Species	*V. unguiculata* (L.)Walp
Sub species	*Sesquipedalis* (L.) Verdc

Source: Wolfram Alpha Knowledge Base, 2011.

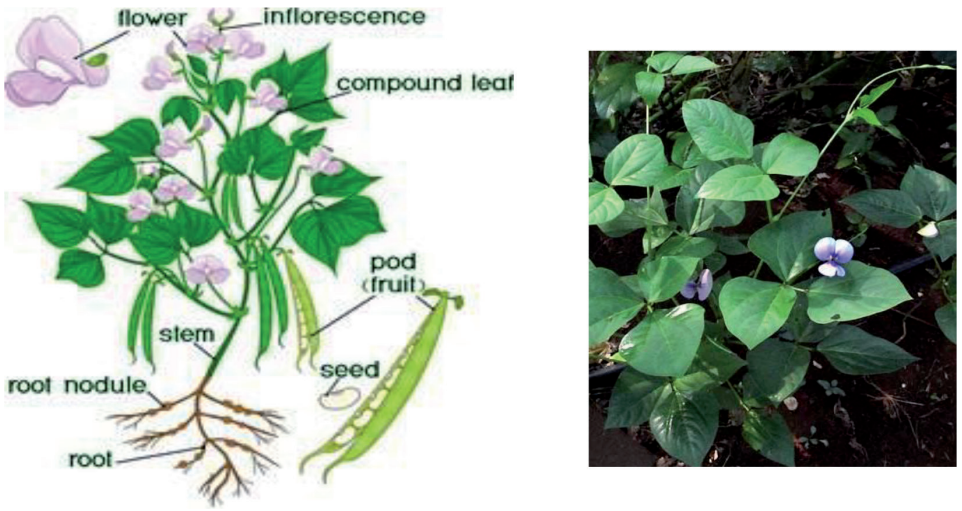


Figure 1.
Morphology of Cowpea.



Figure 2.
V. unguiculata *(L.) Walp Floral Diagram with Floral formula.*



Figure 3.
Variety of cowpea grown by the many countries of people.

The most common important cultivar of cowpea is *V. unguiculata* is globally accepted. The *V. unguiculata* is belongs to tracheobionta sub-kingdom means have well developed xylem for water and ions transport and prominent phloem for storage function. The super division of cow pea is having starchy seeds.

The Magnoliopsida class of this plant describes the ovule enclosed with ovary. The order of the plant os Rosales means the petals separated. This group crops family Fabaceae is particularly bean or pea plants. There are many sub species such as *Sesquipedalis*, *Tenuis, Dekindtiana* and *Stenophylla* characterized in 1993.

Cowpea are annual, small, sub erect herbaceous plant, have tap root system with root nodules, Glabrous stems and leaves are alternate and compound in nature. The fruits have pods and have cross pollination and epigeal seed germination. Inflorecence is receme, flowers bisexual, have five fused sepals and five free petals. It also has polyandrocium and monocarpellary superior ovary (**Figures 1** and **2**).

The word 'cowpea' primarily mentioned in America on 1798. The bean plant fodder was eagerly eating the cow animals, so the name as cowpea. The common name *V. unguiculata* plant is easily identified by the presence of black-eye on the hilum of bean like seeds. These plants cultivated in southern states in the earth. The pea seeds characteristically by pods are tightly closed so called as crowder pea. Their pods based leading to the other common names of southern pea or crowder pea. The cow pea plants varied in different place to place and different varieties of seeds present across the india and other countries (**Figure 3**). The black eyed seeds of the cowpea are common. The sub species *Sesquipedalis* have long pods in Asia so it called Chinese long-bean.

3. Multidimensional applications of cow pea

The cow pea does efficiently fix nitrogen to enhance to fertility of the different kinds soils. This is improvement of biodiversity on the particular cow pea growing area. The Excellent Manures are prepared by the senescence parts of long bean crop. The grains and leaves from cow pea food for all animals including humans and cattle, the cattle milk have rich nutrients as well as improve income of people. Below image describe the various uses of cowpea in daily life (**Figure 4**).

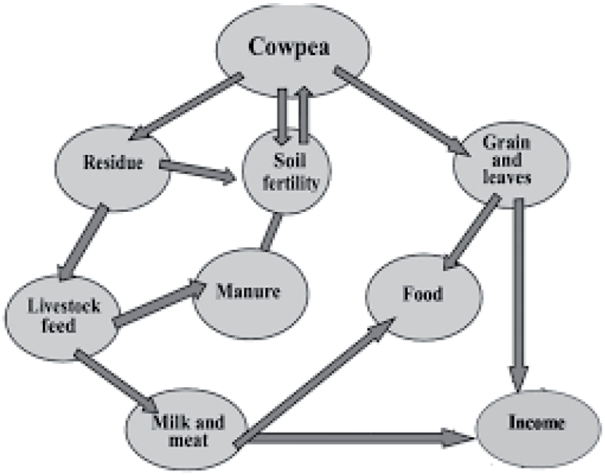


Figure 4.
Cow pea consider as source of income and multidimensional applications.

4. Nutritional aspects of cowpea

The seeds from cowpea seeds have high content of proteins, carbohydrates, low cholesterol, minerals and vitamins. The leaves of cowpea also have high proteins. The calorie values are higher in cowpea when compare to other crops. The nutrient value will be more and easily cultivable even in polluted or low mineral soils, so many countries consider it is important chief food source.

The homo-polysaccharide starch is present in all crops but in cowpea has to do delay in digestion than other crop starch, so it is good for all animals as well as

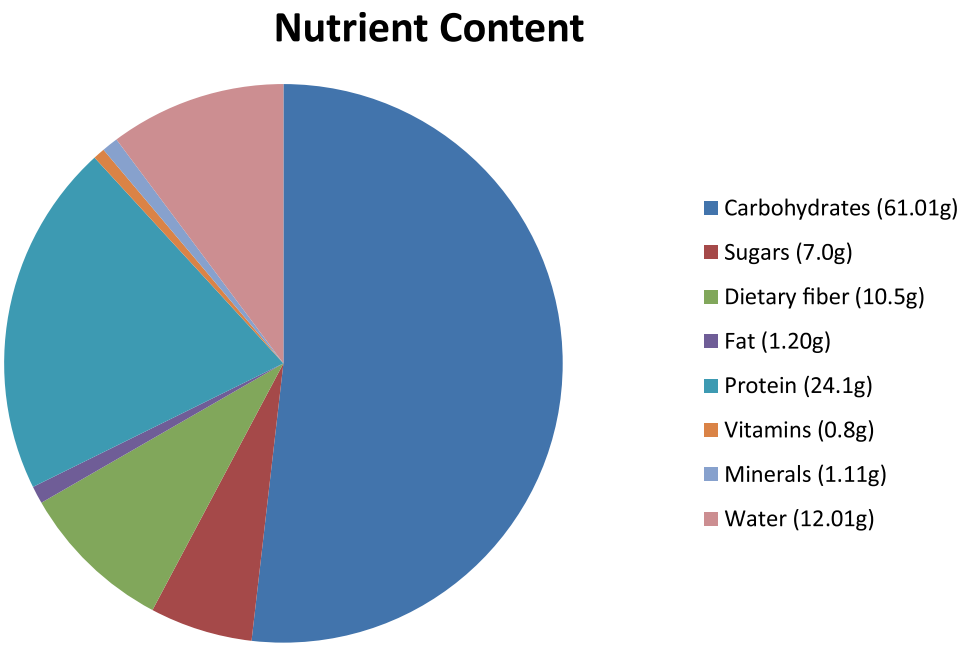


Figure 5.
Nutrient content of cow pea seeds (g/100 g).

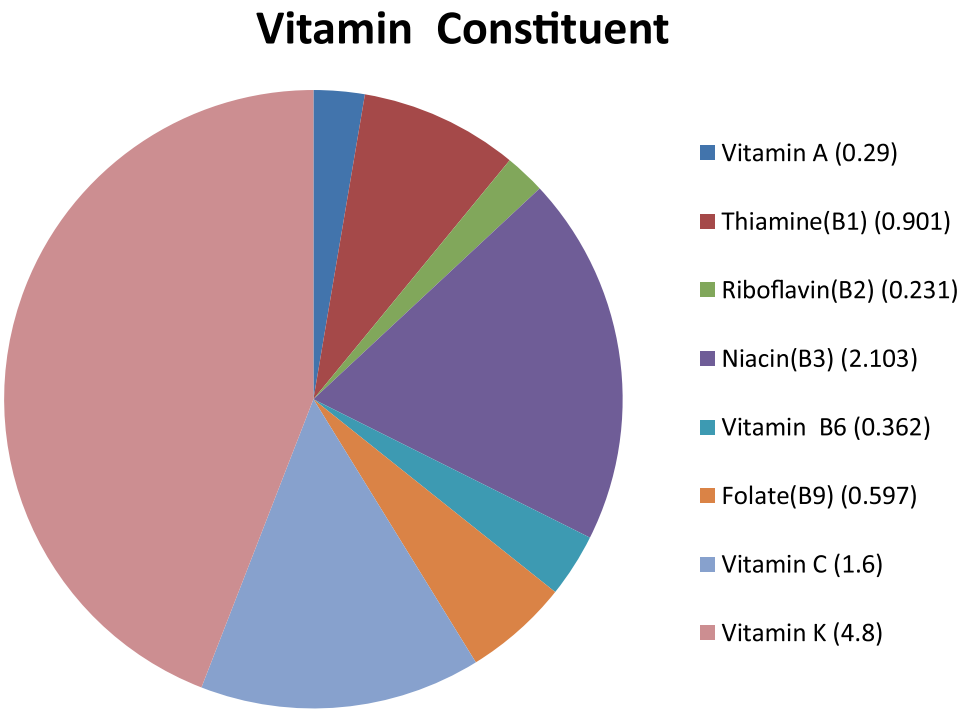


Figure 6.
Vitamin constituent of cow pea seeds (g/100 g).

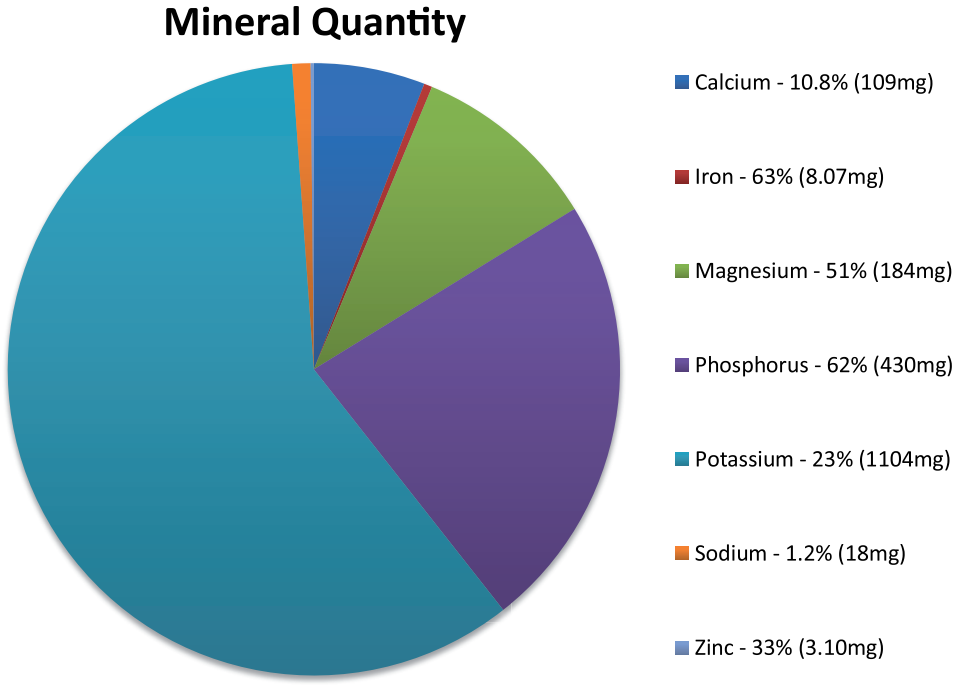


Figure 7.
Mineral quantity of cow pea seeds (g/100 g).

people consumption. The cowpeas seed have high content of vitamin B9 and helps in reduce or remove inborn error metabolism by means of efficiently develop neural tube in babies like fetus.

The cowpea cultivated by very poor people so it is called poor man crop and easy to grow under high drought conditions. These beans have phyticacids and some metabolic inhibitors which decrease the nutritional value. Some physiological methods like soaking, autoclaving fermentation, seed germination and stage of debranning used for the anti-nutritional properties of the cowpea by to is increased the cowpea nutrient bioavailability in soil.

Although the researchers has been identified importance of nutrients in many crop varieties. The anti-nutritional factors are high in dried seeds in some corps including cowpea than young or old leaves and pods. The below the images (**Figure 5**) describes the nutrient values, (**Figure 6**) describes the vitamin constituents and (**Figure 7**) describes the mineral quantity present in gram/100 gram of dried seeds or leaves.

5. Nutraceutical aspects of cowpea

Vegetable-based food systems are more sustainable than meat-based ones because it requires less energy, land, and water resources. The proteins from pulses is used for the balanced growth with have high nutrients to prevent human diseases and maintain good health [2].

The cowpea plants have highest medical constituents such as high fibers, important vitamins like vitamin B complex, folic acids and vitamin K for to promote good health. Cowpea has more potassium content, it lowers cholesterol, low fat, have high iron and antioxidants and do weight loss (**Figure 8**). The phenolics and carotenoids components and anthocyanins pigments are involved and maintain good anabolic and catabolic processes [3, 4].

The seed content of cowpea is used for decrease cholesterol formation so to decrease the body weight [5], cowpea seeds also increase blood cells in hematopoiesis to improve cardiac circulation and do efficient food digestion and also reduce digestive problems such as constipation, etc. [6]. The cow plants have lack of glycemic content of index is to delay the digestion of starch, so the cowpea seeds have high dietary fiber involved in insulin metabolism to decrease hunger for approximately in twelve hours [7].

Cowpea regular consumption to cause prevent or reduce many chronic communicable and non communicable diseases [8], the cow pea seeds have high nutrients to remove many gastric syndromes [6]. Cowpea beans also eradicate many heart diseases,



Figure 8.
V. unguiculata *(L.) Walp have approximately ten medical applications.*

decrease cholesterol diseases and improve weight loss [9]. Cowpea seeds or leaves have many medical properties, including reduce carcinoma, improve insulin, reduce lipid diseases, decrease pathogenic infections and remove certain allergies [10, 11].

The high content of carbohydrates, proteins as well as essential amino acids of cowpea seeds used for many health or therapeutic purposes. Cowpea proteins are highly valuable for both consumption and some culinary and some cowpea seed proteins also used for designing the texture of foods [12]. High regular intake of cowpea seeds may reduce blood plasma cholesterol like low density lipoprotein and also reduce non communicable diseases like many cancers and atherosclerosis or myogenic heart diseases [13].

6. Symbiotic relationship of cowpea for environmental protection

Legume plants are known to form symbioses with extremely broad range of beneficial soil microorganisms (BSM), the examples of almost all plant-microbe mutuality systems present in soil. The different legume plants have interaction with many beneficial microorganisms to increase nutritious, minerals and also do the intake of water from soil via prominent root hairs (**Figure 9**).

Cowpea plants promote the other plant development and also give protection to many bacterial of fungal plant pathogens and insect-pests. In the field of environmental sciences and agricultural aspects, the cowpea consider do most important beneficial legume to do the symbioses, they are bacterial specifically root nodule (RN) symbiosis and the fungi particularly arbuscular mycorrhiza (AM).

These symbioses explains the metabolic and genetically relations with host plants and have that plant growth promoting rhizosphere bacteria which are

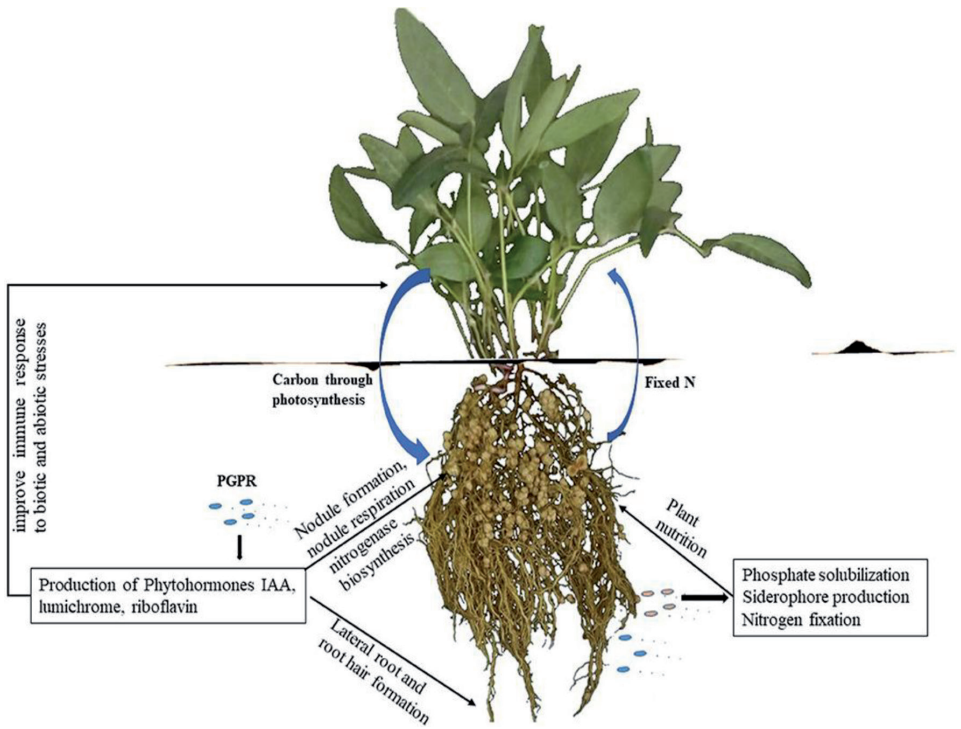


Figure 9.
Cowpea (Legumes) involved in N2 fixation and Carbon fixation. Courtesy: Sanjay K. Jaiswal, Frontiers in Sustainable Food Systems.

beneficial endophytic bacteria interact with legumes such as cowpea. The RNS requires a set of genes belonging to common symbiosis signaling pathway (CSSP), most of which are present in all land plants including legumes that can form a second symbiosis with, the fungi arbuscular mycorrhiza (AM) [14, 15].

Legumes are able to fix nitrogen from the air in symbiosis with Rhizobium bacteria [16]. The symbiotic relationship between plants with Rhizobium bacteria or any fungi to do fix the atmospheric nitrogen and compensate the ecological gas balance and also do the growth of crop plants to ultimately improve agriculture and maintain sustainable development of life.

The cowpea plants is eager to absorb high heavy metals such as copper from highly polluted soil or industrial effluents or etc., so it is otherwise called hyper-accumulator plants [17]. The cow pea consider as great pollution eradicator.

7. Conclusion

Cowpea have morphologically and taxonomically well adapted in tropical countries. The herbaceous nature of cowpea is easy for crop cultivation, crop rotation as well as intercrop. It have able to withstand drought or seasonal conditions. The nutrient aspects have more starchy content to proof that stable food for poor people. Cowpeas have other high protein less fat and high vitamins and minerals for maintain excellent metabolism for consuming organisms. Cowpea do fixing atmospheric nitrogen by to symbiotic relations with microorganisms with do recycling with biogeochemical cycles to enhance atmospheric gases.

The cowpea is one of the the largest cultivator crop among legume family and is commonly cultivated crop in most of the countries globally. The cow pea has highest nutrient values so used for maintain good nutrient calories required for our body. This crop plant is considered as good medical applications to cure or reduce the most non-communicable diseases in animals and or human systems. Cow also pea maintain ecological balances by fixing nitrogen, to chelate heavy metals for water and soil pollution removal and it used as bio-fuel production to improve our green environment and reduce fossil fuels to control other environmental pollutions.

8. Summary

V. unguiculata (L.) Walp is considered as green vegetable crop and the dried seeds were placed in pulses. Excellent to cultivation of the crop in any soil type and able to grow most arid climates and induce and develop more farm industries in global scale. Cowpea has poor digestion ability and considered as most stable food for very poor or developing countries. In Neolithic times the black eyed seed is most common starchy food. This crop have more chances to grow in tropical lands.

The morphological aspects ultimately deals with, the cowpea is recognized as an annual crop, herbaceous woody and greenish in nature. The seedlings were early to germinate in less moisture conditions. Cowpea leaves are rich in main green pigments such as chlorophyll *a* and chlorophyll *b* and also have reticulate venation made by vascular bundles. Inflorescence of the plant is raceme with five free petals with five fused sepals. The Androecium is nine plus one in number and is responsible for the development of male gametes. The gynoecium is ready to provide an egg. The double fertilization of the egg with pollen grain to fuse to form fertile black eyed seeds. The seeds nutritional information of cowpea deals with the presence high concentrations of carbohydrates, proteins, minerals and vitamins. The major ingredient is starch among the chemical components was highly recommended.

All vitamins regulate metabolism, specifically high concentration of niacin as coenzymes in cowpea and improve cellular growth. The irons and phosphorous are dominant minerals present in cowpea to regulate growth anabolism and catabolism.

The medical aspects enumerate the cowpea is no limit. The cowpea has high potassium to improve cell signaling in animals. The legume lowers the blood glucose level to reduce the diabetes among humans and it lowers blood cholesterol. The seeds have high in full of dietary fibers to regulate metabolism. The fiber content of cowpea is responsible to maintain very low fat in our body. Cowpeas have marvelous cell antioxidant mechanism to remove reactive oxygen species and reduce the effect certain toxic substances due to stress and radiation. The seeds rich in protein contents, the ingredients of cowpea show wonderful circulatory system and improve cardiac muscle function and lower the blood pressure. The black eyed seeds also induce gall bladder bile secretion for digestion purpose. Cowpea role in to decrease body weight, it means that improve weight loss.

The ecological review deals with by symbiotic relationship among various types of beneficial microorganisms. The root nodules of cowpea have to fix atmospheric nitrogen to ammonia with the help of *Vesicular Arbuscular Mycorrhiza* fungi and also certain bacteria like *Rhizobium* and other some organisms. The *Agrobacterium* also do fix atmospheric nitrogen to by *Nif* genes cowpea induce their flavonoids with acetosyringone to transfer DNA to host plant induce cancers or other mechanisms to improve growth of crop plants.

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