ACTA SCIENTIFIC AGRICULTURE (ISSN: 2581-365X)

Volume 3 Issue 1 January 2019

Review Article

A Review on Amaranth: Nutraceutical and Virtual Plant for Providing Food Security and Nutrients

Mukesh Topwal*

Department of Agriculture, Uttarakhand, India

***Corresponding Author:** Mukesh Topwal, Department of Agriculture, Uttarakhand, India.

Received: October 29, 2018; **Published:** December 03, 2018

Abstract

The major staple food crops are not able to provide food requirement of growing population as well as also not able to increase farmer's income as much as higher especially in developing countries and also need to provide nutritional security to fast growing population. Amaranth as a unique plant with a long and mysterious history is the object for science and also for business. Amaranth grain is extremely nutritional pseudo- cereal with a higher amount of proteins when compared to true cereals. It is a reasonably well-balanced food with functional properties that have been shown to provide medicinal benefits. Amaranth associate underutilized crop and an inexpensive supply of proteins, minerals, vitamin A and C, appears to be a future crop which may substantiate this demand because of its tremendous yield potential and biological process qualities, conjointly recently gained worldwide attention. Consistent with the data received inside the scope of a country wide studies assignment, grain amaranth is acknowledged as a perspective crop appropriate for manufacturing of particularly nutritive food and feed also below our conditions.

Keywords: Amaranth; Origin, Species; Nutritive value; Economic Value

Introduction

Agriculture facing a great pressure to produce greater quantities of food, feed and biofuel on declining land resources for the projected nine billion people on the planet by 2050 [1]. It is envisioned that agricultural production has to increase by 70% by 2050 to cope with an estimated 40% increase in world population [2]. So utilization of underutilized food crop performs a massive function for providing food, feed and vitamin to such increasing population [3]. Amaranth is one of the few multipurpose crops who provide grain, leafy vegetable, fodder, and greater diet then the predominant staple crops [4]. It is a tremendously short-lived annual which develop vigorously, drought resistant and adapt effortlessly to new environments [5]. It is dispensed in tropical America, India, China, Nepal, Italy, Greece, Africa, and Australia [6]. Amaranth is not a "true cereal" such as wheat, corn or barley, but it is rather considered a "pseudo-cereal" like buckwheat (Fagopirum esculentum) and quinoa (Chenopodium quinoa). Amaranth belongs to the order of Caryophyllales and family of Amaranthaceae and to the genus of Amaranth. Amaranth leaves have wonderful chemical composition with mild spinach-like taste so it comes beneath an accurate leafy vegetable [7]. It may be eaten as raw in salad or by cooked along or with other vegetables especially with potato. If pureed they may be the base for specific sauces and dried they can also be used as spice and also a major charter of soup with some other greens and cereals. They may also be combined with flour cereals to prepare noodles or pizzas. Due to its chemical composition, as said above lines, amaranth plays a vital role in nutrition [8].

Origin

By the great establishment and huge spread distribution of grain Amaranthus in Asia, early botanists and explorers thought them to be indigenous to Asia. Amaranthus Grain Amaranth like Amaranthus cruentus L. occur in the Indo Burma area [9-11]. However, domestication of grain Amaranth began in America, based on the data from geographical, morphological, archeological, ethnobotanical and physiological studies [12] [13]. The genus Amaranth in represented in the country Senegal by 4 species, *Amaranthus hybridus* sub spp. cruentus, *Amaranthus graccizans, Amaranthus spinosus* and *Amaranthus viridis* and other two are *Amaranthus*

caudatas var viridis and *Amaranthus caudatus* var. purpureus. The last species could be considered as separate species of genus Amaranthus because of its specific characters [14].

Species

The household Amaranthaceae is typically regarded as the "Amaranth family". The word Amaranthus is basically derived from the Greek word "Anthos" (Flower) which means eternal or unwilting [15]. Based on taxonomical studies, the family is divided into two sections [16], namely *Amaranthus saucer* and *Blitopsis dumort*. The section Amaranthus is dibasic with x = 16 and 17 and Blitopsis with x = 17 accept polyploidy, that is, *Amaranthus dubius* [17-19]. Vegetable amaranth has two major species, *Amaranthus tricolor* and *Amaranthus lividis*. The ornamental species includes *Amaranthus tricolor*. About 400 species of Amaranthus are distributed throughout the world in temperate, subtropical, and tropical climate zones [20] and few of them are distributed worldwide [21]. About 20 species are cultivated or found widely in India. Among grain types some species are considered as native to south and Central America [22] while some other types are native to Europe, Asia, Africa, and Australia [23,24]**.** Three principal species of amaranth originated in South America and belongs to genus Amaranthus, are considered for grain production [13]: *Amaranthus hypochondriacus* L. (sin. *Amaranthus leucocarpus* S. Watts, *Amaranthus frumentaceous*)- prince's feather; *Amaranthus cruentus* L. sin. *Amaranthus paniculatus* L. - bush greens, red amaranth and; *Amaranthus caudatus* L. of two subspecies: subsp. *caudatus*; and subsp. *mantegazzianus passerini* syn.: *Amaranthus edulis Spagazzini,* named love-liebleeding and Inca wheat, respectively. Mostly several amaranthus species have edible leaves, but some species are known as vegetable amaranths; *Amaranthus blitum* L. (sin. *Amaranthus lividus* L.), *Amaranthus viridis* L. (sin. *Amaranthus gracilis* Desf.) and *Amaranthus tricolor* L. (sin. *Amaranthus gangeticus* L.) [25]. Amaranth can be devided into two groups, based on their consumption viz., grain and vegetable amaranths [4]. Some species are shown in figure 1.

Figure 1: Different species of Amaranth.

Vegetable amaranth

Most of the Amaranthus species have suitable for eating leaves, and numerous species (*Amaranthus blitum* L.; sin. *Amaranthus lividus* L., *Amaranthus viridis* L.; sin. *Amaranthus gracilis* Desf. and *Amaranthus tricolor* L.; sin. *Amaranthus gangeticus* L.) are already broadly used as potherbs (boiled greens). Due to its spinach like flavor, high yield, resistance power, magnificent nutritive value, amaranth emerge as a very popular as leafy vegetable in the humid tropics of Africa and Asia amaranthus.

Grain amaranth

Amaranth is a pseudocereals and following three foremost species comes underneath grain amaranth: *Amaranthus hypochondriacus* L. (sin. *Amaranthus leucocarpus* S. Watts, *Amaranthus frumenta ceous*) - prince's feather; *Amaranthus cruentus* L. sin. *Amaranthus paniculatus* L. - bush greens, purple amaranth A*maranthus caudatus* L. of two subspecies: subsp. caudatus; and subsp. *Mantegazzianus Passerini* syn.: *Amaranthus edulis* Spagazzini, named love-lie bleeding and Inca wheat, respectively.

Plant Morphology

Amaranth is a dicotyledonous, herbaceous plant with an erect stem and large inflorescence. Amaranth is C4 plant and belongs into team of NAD-malic enzyme-type of C4 metabolism. Some anatomical characteristics of amaranth and its C4-photosynthesis pathway result in increased efficiency of the usage of CO2 below an extensive vary of temperature (from 25°C to 40°C), below greater mild intensity, and moisture stress environments. All this contribute to the crop's huge geographic adaptability to numerous environmental conditions [26].

Roots

Amaranth have a fast growing root system, which causes it causes roots easily uptake water and nutrition from soil. After days of sowing roots can be reach up to 2.4 m in soil and spread around 1.8 m. This fast growing root system found in both vegetable and grain amaranth, which make it competitive with other crops [26].

Stem

The stem is 0.5 to 3.5 m in height, simple or branched, relying on species, genotype and developing conditions, however usually on plant population. The primary breeding goal of amaranth is minimizing plant peak up to 1.5m and pick out genotypes with a much less degree of branching [27].

Leaves

Leaves are of a number in shapes viz., elliptic, rhombic, ovate, lanceolate or rhombate-ovate, with acute, obtuse or acuminate leaf tips, of green, purple or silver colour. Because of anthocian (amaranthine) colouration, totally purple plant life and flowers with reddish or silver spots on the leaves additionally exist [28].

Inflorescence

Amaranth is a monoecious, flora is unisexual with a pentamerous organization. Each of plant life has a bract of purple, orange, crimson or gold in colour, and is developed on branched flower clusters named glomerules (a glomerulus (sing.) is a fundamental unit of inflorescence and is described as a dichasial (cyme). In each clusters the first flowers are male (staminate) and following are female (pistilate). The crop is frequently pollinated by wind (anemophilus), up to ninety percent pollination takes place on the same crop, but in some genotypes and occasions the price of cross-pollination can enlarge up to 30 %. In each glomerulus, the male flower open before female plant life therefore female plants are pollinated by pollen from other glomerulus [13,26]. Grain type amaranth has a large, more or much less branched inflorescence. *Amaranthus hypochondriacus* and *Amaranthus caudatus* have an erect inflorescence, inflorescence of *Amaranthus cruentus* is semi erect, and the inflorescence of *Amaranthus caudatus* is lax, long and dropping. Most of amaranth inflorescence and branches have indeterminate increase addiction and for this reason can reach long lengths barring for *Amaranthus caudatus* subsp. mantegazzianus which has a determinate or club-shaped inflorescence. Inflorescence can be of a number in colours: yellow, green, purple, orange, pink, violet, brown and two-coloured inflorescence [28].

Seed

Amaranth seed is borne in a utricle, which is categorized as dehiscent, semi-dehiscent, or indehiscent kind (grain shattering relies upon on the type of utricle). The seed of amaranth are white, gold, brown or red to black. Seed is lenticular and tremendously small (0.9 to 1.7 mm diameter) with 1000-seed weight ranging from 0.6 to 1 g [26].

Nutritional Information

Vegetable amaranth

Amaranth leaves consist a sizable electricity cost ranging from 27 to 53 kcal/100 g of sparkling leaves and excessive nutrient value in unique 4-6 g of protein, 0.2-0.6 g of fat, and 4-7 g of carbohydrates (all these values are per a hundred g of clean amaranth leaves) two [8].

	Amaranth leaves
Protein (g)	2.5 - 3.5
Lipids (g)	0.31 - 0.5
Carbohydrates (g)	4 -6
Iron (mg)	2.3 - 3.2
Calcium (mg)	215 - 260
Vitamins C (mg)	43 -55

Table 1: Main nutritional information of amaranth leaves (g/100 g of fresh leaves) Sources: personal elaboration by the authors on data [8].

Amaranth grain: chemical composition and use

Amaranth seed contains sterols in concentrations from 0.27 to 0.32 mg g-1 [29], phospholipids attention in amaranth oil is enormously low (around 5 %), and contents of tocols varies from 191 mg kg-1 [30] to 2,000 mg kg-1 in oil [31]. Amaranth crop interest is specially based on its grain chemical composition (Table 3, 4) and on its agronomic features. The grain structure of amaranth differs from cereals such as maize and wheat, and this impacts its properties. It is now not essential to cast off seed coat from seed due to the fact it is smooth and thin, and collectively with the germ (rich in fat) and perisperm (rich in starch) it represents the intelligence fraction that for quantity (higher percentage) and excellent (higher ranges of protein and fat) is distinctive from normal cereals.

	Amaranth leaves, cooked, boiled, drained, without salt (100 g)	Swiss chard, cooked boiled, drained, without salt (100 g)	Spinach leaves, cooked, boiled, drained, without salt (100 g)
Calories	21.0 kcal	20.0 kcal	23.0 kcal
Carbohydrates	4.1 g	4.1 g	3.8 g
Protein	2.1 g	1.9 g	3.0 g
Calcium	209.0 mg	58.0 mg	136.0 mg
Phosphorous	72.0 mg	33.0 mg	56.0 mg
Iron	2.3 mg	2.3 mg	3.6 mg
Vitamin C	41.1 mg	18.0 mg	9.8 mg
Dietary Fiber	n/a	2.1 g	2.4 g
Folate	57.0 mcg	9.0 mcg	146.0 mcg

Table 2: Nutritional Information for Amaranth and Similar Leaves.

(*According to the United States Department of Agriculture (2007) as posted on the http://www.nal.usdAMARANTHUSgov/fnic/foodcomp/cgi-bin/nut_search_new.pl)

Energy (kcal)	365 - 370	Ash (g)	2.8 - 3.8
Crude Protein (g)	11 - 18	Calcium (mg)	160 - 212
Total lipid (g)	7 - 8.5	Iron (mg)	7 - 15
Carbohydrate (g) Of which Starch (g)	65 - 70 48 - 68	Vitamin C (mg)	4 - 7
Crude fibre (g)	6.5 - 9		

Table 3: Chemical composition of amaranth grain (on 100 g dwb).

Sources: personal elaboration by the authors on data [31,33-35].

Economic Usages

Domestic uses

In India, Amaranth assumes one of a kind significance as they are ate up at some point of the spiritual days of fast. The seeds of Amaranth are popped to be used in the coaching of Laddoos. It is additionally delivered to a mixture of flour to make pastries of pancakes, while the young leaves are used in soups. It could also be included in maize tortillas or mixed with other flours to enrich their protein content. The leaves of Amaranth are eaten as soups, salads, broths and as a vegetable and are used in protein extracts, colouring and laxatives. The inflorescences are used for decoration and the complete top element from floor used for feeding of animals [37].

The nutritive value of grain amaranth with regard to protein, amino acid, mineral contents, nutritional vitamins and meals electricity is most efficient to other conventional cereal crops. It is a multipurpose crop. The smooth inexperienced leaves are used as vegetable. The smooth stem of amaranth is used as drum stick in making curry. In the hills the grains are used in extraordinary culinary preparations, white grains are popped and combined with milk and sugar (sweet porridge, Kheer), popped grains in the sha-

Crops	Amaranth	rye	Buckwheet	Chenopodium	Wheat	Maize	Rice
Protein	16.0	12.1	11.7	12.0	13.3	9.2	7.0
Fat	3.1	1.7	2.4	5.0	2.0	3.9	7.0
Carbohydrate	60.0	73.4	72.9	68.0	71.0	73.7	78.0
Calcium	0.49	0.38	0.12	0.20	0.41	0.20	0.20
Phosphorus	0.60	0.37	0.28	0.50	0.37	0.25	0.18
Iron	17.5	10.5	15.5	12.6	10.5	3.5	3.5
Food Energy	391	334	335	342	333	355	345

Table 4: Comparison of Nutrient values of grain amaranthus with other cereals [36].

pe of candy puddings, whit grains combined with maize and finger millet flour for making chapaties. Popped grains are mixed with sugar syrup to make candy balls (laddoo), in northern India popped grains blended with honey to make flat round breadings, soaked and grinded seeds blended with wheat and fingermillet flour and salt and spices to make delicious paratha and very crisp pakoras are also made of amaranth flour. The black seed is used as cattle feed. The green vegetable is considered as purgative.

Ethnobotany

The grain amaranths are grown on the border of maize fields in Solan and Bilaspur districts of Himachal Pradesh to ward off chicken damaging maize cob (magical impact of crimson inflorescence type). The dried stems are used as gas and considered to destroy rock boulders without difficulty with its smoke when burnt (Uttarakhand). In Kumaon hills local humans consider that the grains assist in curing measles in adolescents (by bringing down the body temperature) when they sleep over the spreader grains of amaranths on the bed. It is additionally regarded as superb remedy for snake bite. In Himachal Pradesh it is viewed that the decoction of grains is very useful and tremendous in cure of foot and mouth diseases of animals, its excessive feeding reasons some mouth ailments to the cattle. In sure areas of Himachal Pradesh, Rohdu, Sarhan, Khanag and Kinnaur, the grain shares are used for meat and apple fruit renovation for 4-6 months and they say that meat continue to be sparkling for one and 1/2 month and end up greater tasty whereas apple remain farm sparkling for four to 6 months when merged in grain boxes of amaranths. In the historic instances the tribal mountain dwellers used grain amaranth stock as reserve meals and there are still farmers in these areas that have 50 yr historic seeds with them. The seed nice and popping do now not deteriorate with ageing and no pests has been viewed in the seed underneath such extended storing [38] pronounced that the species Amaranthus *viridis* is used as a pot herb and in treating snake bites. In Tamilnadu and Kerala hills, the tribe use stem and go away juice of *Amaranthus spinosus* in the cure of kidney stones whereas Bhutan.

In India the leaves of *Amaranthus caudatus* are used as tea to get relief from pulmonary problems and piles and also used in the purification of blood, stragury in scrofula, and as a diuretic [39]. The boiled leaves are used in swellings and in stomach upset [40].

In China the native amaranth roots are used to alleviate cold, as a diuretic, and to check bleeding, treat diarrhea, ulcer, inflammation, throat and mouth problems, diabetes, and allergic reactions dampness [41]. The amaranth plant is sudorific and febrifuge and recommended for eruptive fevers [42].

Agro-industrial uses

Grain amaranth assumes greater nutritional significance as a fancy food crop for elaborating specific industrial products like bread, pastry, biscuits, flakes, crackers, ice-cream and in elaborating lysine prosperous infant foods. The toasted seed flour combined with wheat in 10:90 ratio gave bread of excellent fine as compared to one of 100% wheat. Amaranth meal or flour should be blended with wheat meal or wheat flour because it lacks useful gluten [43]. The new meals products, Amarlac and Amarameal of excessive dietary nice had been lately released in Guatemala by way of the Amaranth Food Company signify the first output of quite a few years of lookup to processing and utilization of amaranth grains and transformed it into high fine human meals mainly for younger adolescents and pregnant girls (Amaranth News Letter 1987). This merchandise can be tried in India. Amaranthus Grain, amaranth germ and bran include 20% oil which can be exploited as suitable for eating oil. The starch that make up the bulk of ama-

ranth flour has extremely small granules (average diameter 1 micron) a unique dodecahedral structure; and high water absorption capacity. It is in all likelihood to prove beneficial for software in the food, high pleasant plastics, cosmetics and other industries. The other new makes use of amaranth are herbal dyes, prescription drugs (laxative) and Squalene, an excessive priced cloth found in amaranth grain but generally received from shark livers and used in cosmetics. The amaranth foliage is edible with organic fee related and even finest to frequent vegetables of popular consumption, consisting of less oxalates and nitrates. Therefore, it can be recommended as necessary meals for human nutrition. In mineral content iron, calcium, phosphorus is found in amaranth green rank at the top. Eighty two percent of India's population lives in rural areas. These area units specifically engaged in agricultural pursuit, Low worth cereals and greens varieties the predominant components of their diet. Dark inexperienced leaves, that area unit in-expensive, area unit prosperous sources of variety of nutrients metal, iron, carotene, riboflavin, vitamin B complex and water-soluble vitamin, that entire area unit very important for boom and preservation of standard health.

Conclusion

As can be concluded from the above description of amaranth in this article, there is a great potential to increasing farmers income and provide nutritional security to increasing population and more diversified and sustainable food production system. The research on these crops for exploring their ultimate yield potential is currently at a plateau level. To replace the existing pressure on these major crops there is an urgent need to explore other alternative crops having the potential to replace and fulfill the available food demand.

Bibliography

1. Godfray H., *et al*. "Food security: The challenge of feeding 9 billion people". *Science* 327 (2010): 812-818.

2. Bruinsma J. "The Resource Outlook to 2050: By How Much Do Land, Water and Crop Yields Need to Increase by 2050?" In Proceedings of the Technical Meeting of Experts on How to Feed the World in 2050, Rome, Italy, 24-26 June 2009; Food and Agriculture Organization (FAO): Rome, Italy (2009): 1-33.

3. Ebert AW. "Potential of Underutilized Traditional Vegetables and Legume Crops to Contribute to Food and Nutritional Security, Income and More Sustainable Production Systems". *Sustainability* 6 (2010): 319-335.

4. Mlakar SG., *et al*. "Nutrition value and use of grain amaranth: potential future application in bread making". *Agricultura* 6 (2009): 43-53.

5. Norman JC. "Tropical Vegetable Crops; Stockwell: Ilfracombe, UK, (1992): 52-77.

6. Stallknecht GF., *et al*. "Amaranth Rediscovered. In New Crops; Janick, J., Simon, J. E., Eds.; Wiley.New York, NY, USA; (1993): 211-218.

7. Amicarelli V and Camaggio G. "Amaranthus: A Crop to Rediscover". *Forum Ware International* 2 (2012): 4-11.

8. Uusikua NP., *et al*. "Nutritional value of leafy vegetables of sub-Saharan Africa and their potential contribution to human health: A review". *Journal of Food Composition and Analysis* 23 (2010): 499-509.

9. Candolle A. "De. Origin of cultivated plants (1886).

10. Vavilov NI. "The origin, variation, immunity and breeding of plants". *Soil Science* (1951): 364.

11. Darlington CD. "Chromosome, botany and origins of cultivated plants". George Allen and Uncoin, London (1963).

12. Sauer JD. "The grain amaranths a survey of their history and classification". *Annals of the Missouri Botanical Garden* 37 (1950): 561-619.

13. Sauer JD. "The grain amaranths and their relatives: a revised taxonomic and geographic survey". *Annals of the Missouri Botanical Garden* 54 (1967): 103-137.

14. Sarr RS., *et al*. "De La Systématique Du Genre Amaranthus L. (Amaranthaceae) Au Sénégal Taxonomic Revision of The Genus Amaranthus In Sénégal". *Journal of Plant Taxonomy and Geography* 61.2 (2006).

15. Rastogi A and Shukla S. "Amaranth: A New Millennium Crop of Nutraceutical Values". *Critical Reviews in Food Science and Nutrition* 53 (2013): 109-125.

16. Allen P. "Die Amaranthaceen Mittleleuropas Carl Verlag, Munchen (1961).

17. Pal M. "Evolution and improvement of cultivated amaranths. I. Breeding system and inflorescence structure". *Proceedings of the Indian National Science Academy* 38 (1972):28-37.

18. Pal M and Khoshoo TMTN. "Grain amaranths". National Botanical Gardens (1965).

19. Madhusoodanan KJ and Pal M. "Cytology of vegetable Amaranths". *Botanical Journal of the Linnean Society* 82 (1981): 61-68.

20. Suma S., *et al*. "Allelopathic plants. 6. Amaranth spp". *Allelopathy Journal*10 (2002): 1-11.

21. Anonymous. "The Wealth of India". Publications and Information Directorate, CSIR, New Delhi, India (1992).

22. Grubben GJH and Van Stolen DH. "Genetic resources and Amaranths". *International Board for Plant Genetic Resources* FAO Rome (1981).

23. Becker R., *et al*. "A compositional study of Amaranth grain". *Journal of Food Science* 46 (1981): 1175.

24. Teutonico R., *et al*. "Non-destructive method for oxalate determination of cultured Amaranthus tricolor cells". *Journal of Agricultural and Food Chemistry* 33 (1985): 60-64.

25. Schnetzler KA and Breene WM. "Food uses and amaranth product research: a comprehensive review. In: Peredes- López O (ed), Amaranth biology, chemistry and technology. CRC Press, Boca Raton, FL (1994): 155-184.

26. Kigel J. "Development and Ecophysiology of Amaranths". In: Peredes-López O (ed), Amaranth biology, chemistry and technology. CRC Press, Boca Raton, FL (1994): 39-73.

27. Kaufman CS. "Realizing the Potential of Grain Amaranth". *Food Reviews International* 8 (1992): 5-21.

28. Williams JT and Brenner D. "Grain amaranth (Amaranthus species). In: Williams JT (ed), Underutilized Crops: Cereals and Pseudocereals. Chapman and Hall, London, UK (1995): 129-187.

29. Leon-Camacho M., *et al*. "A detailed study of amaranth (Amaranthus cruentus L.) oil fatty profile". *European Food Research and Technology* 213 (2001): 349-355.

30. Becker R. "Amaranth oil: Composition, processing and nutritional qualities". In: Peredes-López O (ed), Amaranth Biology, Chemistry and Technology. CRC Press, Boca Raton, FL (1994) :133-141.

31. Berghofer E and Schoenlechner R. "Grain Amaranth. In: Belton P, Taylor J (eds), Pseudocereals and less common cereals, grain properties and utilization potential". Springer-Verla (2002): 219-260.

32. Bressani R. "Amaranth, In: Macrae, R., Robinson, R.K., Sadler M.J., (Editors)". Encyclopaedia of Food Science, Food Technology and Nutrition 1 (1993): 135-140.

33. Caselato-Sousa VM and Amaya-Farfán J. "State of knowledge on amaranth grain: a comprehensive review". *Journal of Food Science* 4 (2012): 93-104.

34. Barba de la Rosa., *et al*. "Amaranth (Amaranthus hypochondriacus) as an alternative crop for sustainable food production: Phenolic acids and flavonoids with potential impact on its nutraceutical quality". *Journal of Cereal Science* 49 (2009): 117-121.

35. Valcárcel-Yamani B., *et al*. "Applications of Quinoa (Chenopodium Quinoa Willd.) and Amaranth (Amaranthus Spp.) and Their Influence in the Nutritional Value of Cereal Based Foods". *Food and Public Health* 2 (2012): 265-275.

36. Joshi B D and Rana RS. "Grain amaranths: the future food crop". National bureau of plant genetic resources New Delhi, India (1991).

37. Ravindran V., *et al*. "Nutritional evaluation of grain amaranth (A. hypochondriacus L.) in broiler diets". *Animal Feed Science and Technology* 63 (1996): 1-4.

38. Behari M., *et al*. "24 - Alky I - 6.7 -Steroles of the herb Amaranthus viridis". *Fitoterapia* 57 (1986): 276-277.

39. Gupta A., *et al*. "Reviews on Indian Medicinal Plants: Indian Council of Medical Research, New Delhi, India 2 (2004).

40. Michael H. "South American Medicinal Plants: Botany, Remedial Properties and General Use". Roth, I. and Lindorf, H., Eds., Springer, Berlin (2002).

41. Bi Fong, L., *et al*. "Amaranthus spinosus water extract directly stimulates proliferation of β- lymphocytes in vitro". *International Immunopharmacology* 5 (2005): 711-722.

42. Yoganarasimthan SN. "Medicinal Plants of Tamil Nadu". *USDA National Research Council* (2000): 2.

43. Sanche i-Marroquin A. "Two forgotten crops of agro-industrial importance: amaranth and quinoa". *Archives Latino americanos de Nutricion 33* (1983): 11-32.

Volume 3 Issue 1 January 2019