International Journal of Multidisciplinary Research and Development
Online ISSN: 2349-4182, Print ISSN: 2349-5979, Impact Factor: RJIF 5.72
www.allsubjectjournal.com
Volume 3; Issue 3; March 2016; Page No. 214-223

Processing and value addition of the underutilized agriculture crops and indigenous fruits of Bastar region of Chhattisgarh

[1] Neeta Dandsena, [2] Ajay Banik

[1] R.A.E.O, Agriculture Department, Chhattisgarh, India.

[2] SOS Forestry & Wildlife; BVV, Chhattisgarh, India.

Abstract
The tribal populations of Bastar region of Chhattisgarh rely heavily on forest food gathering during the lean period i.e. summer and engaged in agricultural activities for their livelihood in the farming period. The weather conditions of Bastar provides congenial environment for growing a variety of underutilized millets and indigenous fruits. These crops belonging to categories such as cereals and pseudo cereals, legumes, vegetables, oilseeds, roots and tubers, aromatic and medicinal plants, fruits and nuts, have earned collective names such as 'neglected and underutilized' or 'forgotten', 'orphan', 'minor' crops (Padulosi *et al.*, 2004, 2008).

This paper attempts to study the potential of underutilized crops and indigenous fruit and their value-addition as well as popularization in particular found in Bastar region of Chhattisgarh through production to consumption system (PCS value-chain).

The close adaptive relationship between the tribal and the environment has enabled them to grow, manage and collect many lesser known agricultural or non-timber forest species which are available only in the local markets and practically unknown in other parts of the world. The leaves, seeds, flowers, and fruit of many indigenous plants enrich the staple diet of the local populace. The local cereals such as minor millets namely Finger millet (ragi or *Eleusine coracana*), Kodo millet (Kodo, *Paspalum scrobiculatum*), Little millet (Kutki, *Panicum sumatrense*), Foxtail millet (Gatka, *Setaria italica*), Proso millet (Kosra, *Panicum milliaceum*), Barnyard millet (Sawan, *Echinochloa frumentacea*) and Red rice (Wild rice, *Oryza nivara*) traditionally cooked and consumed in boiled or semi liquid form (porridge) locally called as 'PEJ' and in fermented beverage, also indigenous pulses like Rice bean (Sutari, *Vigna Umbellata*), Horse gram (Kulthi, *Dolichos biflorus*), Field cowpea (Lobia, *Vigna unguiculata*) consumed in boiled form. Wild plant produces Vegetables like Ashgourd (*Benincasa hispida*) as Curry, Roselle (*Hibiscus sabdariffa*) as dip (Chutney) and wild fruits like custard apple (*Annona Squamosa*), Tamarind (*Tamarindus indica*), Jack fruit (*Artocarpus heterophyllus*), Ber (Zizyphus mauritiana), Jamun (Syzygium cumini) and Aonla (*Emblica officinalies Linn*) are consumed in ripen stage as fruit and are sold in local markets; they are produced in abundance in the forests in different seasons but lacking in value addition and food value.

Aforementioned Underutilized crops i.e., Kodo and Barnyard millet based nutritious value added food items are also used to prepare popped millets, bakery items like biscuits and muffins, fried products like *chakli, khakra*, etc. Finger millet based ragi health drink (baby food), malt, multi-grain noodle, ragi biscuit, ragi vermicelli prepared from millet flour, and Red rice based fermented food items like ready to cook Idli, Dosa, kheer and pancakes mix snacks that will appeal to the younger generation as novel snack items. Rice bean (Sutari, *Vigna Umbellata*) as a dal, curry, soups ready to cook mix and sauces, Roselle (*Hibiscus sabdariffa*) is used in making herbal tea, soft drinks, Jam and Jelly. Indigenous fruit i.e. Jack fruit (*Artocarpus heterophyllus*) for chips, curry mix and pickle making Jamun (Syzygium cumini) for making squash and from Aonla (*Emblica officinalies* L.) Chavanprash, triphala, pickle, preserved candy, jam, syrup, juice and dried shreds are made.

Publicity, awareness campaigns and training are important and innovative approaches of popularization will help in capturing the market share. Policy makers are to be sensitized on health and nutritional benefits of processed millets and wild foods on target populations such as school children-midday meal scheme and poor social groups-PDS system and health-conscious consumers.

Keywords: Underutilized agriculture crops, Indigenous fruits, Processing and Value addition

Introduction

The Bastar region rich in floristic diversity is also known for its vibrant tribal culture. About 70 percent residential population of Bastar region belongs to tribal groups and their livelihood is directly or indirectly dependent on these forest and agricultural activities. Tribal depends on forest for their need of medicine, food, fuel, fodder and other non-timber forest products (NTFPs). In areas adjacent to the forests, most people (including those who own some land) gather minor forest produce. A major part of these produces are for household consumption and income is based on forest gathering, however agricultural activities providing supplementary income. Forest foods are nutritionally important and are traditionally used as supplements to the staple diet. Leafy vegetables and wild animals add diversity, flavor, vitamins and minerals to characteristically grain-dominated diets.

Locally harvested underutilized small millets, and vegetables and indigenous fruits provide food as well as cash income for indigenous people and are of great importance in ensuring

global food security. Some also play a significant role in maintaining the productivity and stability of traditional agro-ecosystems. These little-known underutilized agriculture crops and a wide variety of indigenous fruits and vegetables contribute to food security and play vital roles in the nutrition that enrich the diet of the rural populace. Though the staple diet of the Adivasis in this district is rice or Pej (a semi-liquid food drink prepared by boiling the millets, cereals and rice), y*et al*most every Adivasi supplements his cultivated foods with fruits, seeds, leaves and tubers of wild growing plants and with wild or domesticated animals.(Jain S.K,1963)

Often referred to as "minor, orphan, neglected, underexploited, underdeveloped, lost, new, novel, promising, alternative, local, traditional and niche crops," underutilized plant species have been defined and interpreted in many ways (Padulosi *et al*., 2002:325). The term "underutilized" is used to refer to those plant species, which were widely grown in the past, but not at present for various reasons relating to economics and agronomics; the term "neglected" refers to those plant species that have created a special niche in the lives of rural farmers who still cultivate them, yet have received much less attention from a research and development perspective (Padulosi *et al*., 2002). Underutilized and neglected plant species are globally scarce but locally abundant because local people and local communities value such plant species as sources of food, income and nutrition (Gruere *et al*., 2006). Underutilized is commonly applied to refer to species whose potential has not been fully realized. Many underutilized crops were once more widely grown but are today falling into disuse for a variety of agronomic, genetic, economic and cultural factors. Farmers and consumers are using these crops less because they are in some way not competitive with other crop species in the same agricultural environment. The general decline of these crops may erode the genetic base and preventing the use of distinctive useful traits in crop adaptation and improvement.

Indigenous fruit crops are fruit types that are found diversely in the region. They are seed-associated structures of certain plants that are sweet and edible in the raw state. The underutilized fruits like aonla, bael, jamun, karonda, passion fruit, phalsa, pomegranate, pumpkin, tamarind, wood apple etc. are the main sources of livelihood for the poor and play an important role in overcoming the problem of malnutrition (Gajanana *et al.*, 2010).

Processing of food products refers to various techniques and operations by which raw foodstuffs are transformed into food that are suitable for consumption, cooking, or storage. It consists of processes like the basic preparation of foods, the alteration of a food product into another form (as in making preserves from fruit), and preservation and packaging techniques. Processing involves any type of value addition to agricultural or fruit produce and also includes processes such as grading, sorting and packaging which enhance shelf life of food products. Mincing and macerating, Liquefaction, Emulsification, Cooking (such as boiling, broiling, frying, or grilling), Pickling and preservation, Canning or jarring (primary-processing such as Dicing or slicing, Freezing or drying when leading to secondary products are also included). It is necessary to employ modern methods to extend storage life for better distribution and also processing techniques to preserve them for utilization in the offseason in both large and small scale (Bhattacharyya and Bhattacharjee, 2007; Jena *et al.,* 2013). These activities or a combination thereof, result in the manufacture value added products i.e., ready-to-cook or precooked food products like confectionery, instant foods, flavored and health drinks, pickles, jams, flakes, juices, purees, canned foods, powders and mixes, jellies, sauces, oils, etc.

Need Of Processing and Value Addition

Despite the vast genetic diversity of fruits, only important fruits like mango, banana, citrus and guava have gained in the productivity and acceptability by the people. Many of the indigenous fruits and crops have still remained underexploited due to the lack of awareness of their potential, market demand and low and erratic bearing in many cases. The diversification and modernization of present agricultural and forestry related activities supported by efficient processing of the commodities for the purpose of value addition is expected to increase food production, create employment and generate income hence by adding value to the food commodities after harvest will minimize the losses during preservation and processing of these produces may bring more benefits, resulting in more income to the tribal farmers or processors, in entrepreneurship development and will provide better quality of produce to the consumer.

Since Bastar region has abundant raw material for processing, there is huge demand for basic value added services such as grading, cleaning and washing. Currently there is negligible supply of these services in the state indicates ample of opportunities for new investors to set up processing plants in the region focused on value addition.

Some of these crops are also amenable to be grown along with competing cash crops and thus supplement the local food production. The unique strength of certain underutilized and neglected crops in their rich and favourable nutritional composition, nutraceutical value and product development offers uncommon opportunities for income generation to the farmers, in particular the farm women. The overall impact of such interventions on these groups of crops to the socio-economics of the communities conserving and cultivating them, enhancing their food and nutritional security and strengthening of their traditional food culture. In the case of the underutilized and neglected plant species, markets and market related problems, for example lack of market access, weak market demand, poor market structure, market incentives, and improper market chains have been identified as some of the many concerns that small-scale farmers face (Guiliani, 2007).

Table 1: Nutritional composition of some underutilized crops and indigenous fruits

S. No.		Energy (Kcals)	Moisture (g)	Protein (g)	Fat (g)	Mineral (g)	Fibre (g)	Carbohy Drates (g)	Calcium (mg)	Phosph Orus (mg)	Iron (mg)
	Minor Millets										
1	Finger millet (Ragi, *Eleusine coracana*)	328	13.1	7.3	1.3	2.7	3.6	72.0	344	283	3.9
2	Kodo millet (Kodo, *Paspalum scrobiculatum*)	309	12.8	8.3	1.4	2.6	9.0	65.0	27	188	0.5
3	Little millet (Kutki, *Panicum sumatrense*),	341	11.5	7.7	4.7	1.5	7.6	67.0	17	220	9.3
4	Foxtail millet (Gatka, *Setaria italica*)	336	11.2	12.3	4.3	3.3	8.0	60.9	31	290	8
5	Proso millet (Kosra, *Panicum milliaceum*)	328	11.9	12.5	1.3	2.7	3.6	72.0	344	283	3.9
6	Barnyard millet (Sawan, *Echinochloa frumentacea*)	307	11.9	6.2	2.2	4.4	9.8	65.5	20	280	5
	Indigenous Cereal Grains										
7	Red rice (Wild rice, *Oryza nivara*)			13.9	4.0		2.9	74.8	40	550	16.8
	Indigenous Pulses										
8	Rice bean (*Sutari, Vigna Umbellata*)	332	9.6	21.4	0.3	3.5	4.2	60.9	302	297	0
9	Horse gram (Kulthi, *Dolichos biflorus*)	321	11.8	22	0.5	3.2	5.3	57.2	287	311	8.4
10	Field cowpea ((Lobia, *Vigna unguiculata*)	323	13.4	24.1	1	3.2	3.8	54.5	77	414	5.9
	Wild Plant Produces										
11	Ashgourd (*Benincasa hispida*)	10	96.5	0.4	0.1	0.3	0.8	1.9	30	20	0.8
12	Roselle *(Hibiscus sabdariffa*)	49	9.2	1.145	2.61	0	12.0	11.31	215	273.2	8.98
13	Custard apple (*Annona Squamosa*)	104	70.5	1.6	0.4	0.9	3.1	23.5	17	47	4.31
14	Tamarind *(Tamarindus indica*)	283	20.9	3.1	0.1	2.9	5.6	67.4	170	110	17
15	Jack fruit (*Artocarpus heterophyllus*)	88	76.2	1.9	0.1	0.9	1.1	19.8	20	41	0.56
16	Ber (Zizyphus mauritiana)	74	82	0.8	0.3	0.3	0	17	4	9	0.5
17	Jamun (Syzygium cumini)	62	83.7	0.7	0.3	0.4	0.9	14.0	1.3	0.19	1.41
18	Aonla (*Emblica officinalies* L.)	58	82	0.5	0.1	0.5	3.4	14	50	20	1.2

Source: Gopalan *et al* (1978), Red rice (Salih & Nour, 1992), Roselle: (Mahadevan *et al* 2009)

Processing of Coarse Cereals

The tribal today still dependent on manual methods of harvesting of these crops, bullock treading, storage in mud bins and gunny bags and milling by manual chakkis or mills. There are power operated equipment available for all operations including threshing, pearling and milling. For storage of coarse cereals, metal bins have been designed by various institutes. Technology has also been developed for production of value-added products from coarse cereals such as extruded snacks developed from ragi, ready-to- eat traditional foods with storage life of 6-9 months. Efforts are required to develop high yielding varieties of coarse crops with desired characteristics for different uses and to explore new food uses. Safe storage of the flour produced from most of the coarse cereals has been a problem due to its high degree of perishability. This problem needs to be solved.

Processing of Pulses

Pulses were generally stored in gunny bags or in small tin containers under straw cover till today. Now metal bins and gunny bags (with profilectic treatment by insecticides) were in use. Study says pulse grains need to be stored at 20-22 degree Celsius in partially airtight containers at 8-10 per cent moisture content for long duration storage. A number of plant based mild insecticides and insect repellents (such as, neem seed powder) have been developed for safe storage of seeds. In the area of milling of pulses, a dal mill has been developed that has the advantage of not being dependent on natural sun shine. It involves subjecting the pulse grain to high temperature (120 degree Celsius) for short time and the dehusking by carborundum rollers resulting in higher dal recovery. For small entrepreneurs in rural areas, dal mills have been designed, having improved machinery including cleaners, graders, magnetic separators, washers, driers, polishers, colour sorters and packaging systems are being used. With complete phasing out of hand operated dal chakkis, commonly used during 1950s, the technology has turned fully mechanized and more-and-more urban based. There is a need to evolve more efficient machines and processes for pre-treatment of the grain, dehusking, sorting, polishing and packaging in order to improve dal recovery and consume less energy. Also, there is a need for product diversification and development of technology for quick cooking and ready-to-eat dal.

Processing of Rice

Earlier, hand pounding, pedal limited application of expanders are replaced by power operated. Among most common value-added products of rice include puffed and flaked rice used as snack foods. Significant achievements have been recorded in packaging technology for milled rice for ready-to-cook applications in domestic market and export. The upcoming areas in rice processing include high capacity dehuskers and more efficient polishers improved technology for storage of paddy and rice, on farm/ community level drying of paddy, mechanical handling systems for grain markets and millers, cold storage of rice and downstream products, products diversification in the form of flakes, puffed rice, snacks, bakery items, quick cooking and ready-to-eat rice etc. The recovery of brown rice as obtained from the hullers, shellers, and modern mills could be in the range of 62-70 per cent, respectively. The potential yield of rice is 70-72%. The need is therefore, to promote modern rice mills and develop milling technology for fine rice.

Processing of Fruits and Vegetables

Significant developments in technology include better understanding of the process of ripening of fruits, optimum harvesting time, pre-cooling of freshly harvested produce, cold storing of the raw fruits and vegetables, sorting, cleaning, waxing, packaging technology for fruits. Technology for ripening of the fruits under controlled conditions, Production of juices and value-added products including jams, jellies, pickles, canned products etc. has become a commercial

success. The industry using indigenous technology includes units engaged in juice extraction, concentration of juices, canning and production of several of the products like jams, jellies, canned fruits, dried vegetables etc. Technology is still being imported for establishment of large scale exported oriented units for production of items like fruit pastes, concentrates of various fruit juices, sorting, cleaning

Value addition in underutilized cereal grains

Small millet

Millet is a delicious gluten-free cereal grain that is very similar in taste and texture to rice. Millets are tiny in size and round in shape and can be white, gray, yellow or red. Grain packed with protein and many other essential nutrients and is considered to be one of the most easily digestible grains available. Traditionally, dry, moistened or wet grain is normally pounded with a wooden pestle in a wooden or stone mortar. Moistening the grain by adding about 10% water facilitates not only the removal of fibrous bran, but also the separation of germ and endosperm, if desired. Although this practice produces slightly moist flour (Perten, 1983), parboiling increases the dehusking efficiency of kodo millet (Shrestha, 1972) and to eliminate the stickiness in cooked finger millet porridge (Desikachar, 1975). The polished grain called ‘millet rice’ is either used directly or further milled in plate or hammer mill to semolina or flour. These processing add value to these millets three to four-fold and make them acceptable to the elite urban consumers as niche food or health food.

Kodo millet (*Paspalum scrobiculatum*)

Kodo millet locally called Koda, is a nutritious grain and a good substitute to rice or wheat. The fibre content of the whole grain is very high.

Value addition in Kodo millet

Traditionally it is cooked like rice and a fermented beverage called 'Landa'. Kodo millet is ground into flour and used to make pudding etc. Two commercial products such as noodles, rusk and two homemade recipes such as dosa and chapatti were prepared using composite flour of different combinations. (T.P. Vijayakumar, 2014). Kodo millet based *chapathi* and *dosa* and two commercial products viz., noodles and rusk were developed by Poongodi *et al.* (2003).

Finger millet (*Eleusine coracana*)

Finger millet or the *ragi*, locally known as Mandia, is usually used for preparation of flour, pudding, porridge and roti (Chaturvedi *et al*., 2008). Traditionally *ragi* is processed either by malting or fermentation (Rao *et al*., 2001). Malting of finger millet improves its digestibility, sensory and nutritional quality as well as pronounced effect in the lowering the antinutrients. Finger millet is well comparable and even superior to many cereals in terms of mineral and micronutrient contents. Its major use as food has remained only in the area where it is cultivated and to the traditional preparations (Amadou *et al*, 2011)

Value addition in finger millet

Finger millet flour used for convenience foods preparations ie, Spaghetti, macaroni, vermicelli and noodles are through cold extrusion system, Finger millet malt, one of the simplest recipe for weaning food, a combination of cereal and legume, Finger millet papad, Ready-to-eat (RTE) puffed finger millet mix which requires no further cooking and with proper packaging it can be hygienically fed to children in feeding and pregnant and lactating mothers, bakery products like bread and biscuits is also possible. (Verma V. and Patel S. 2013)

Little Millet (*Panicum sumatrense*)

It is called Kutki in Hindi and locally called 'Chikma'. The seeds of little millet are smaller than those of common millet. Little Millet has the highest fat content of all the millets and a good level of protein.

Value addition in little millet

It is used for preparing commonly as *bread, roti, dosa, rice.* It comes in form of rice, semolina and flour.

Foxtail millet (Setaria italica)

Fox tail millet called Kangni in hindi and locally as 'Gatka' – The grain of foxtail millet is ovoid in shape, 2 mm long, pale yellow to orange, red, brown or black in colour. It is enclosed in thin hulls and should undergo de-husking before being stored and processed for food (Ecoport, 2011; FAO, 2011; Brink, 2006). It is good source of dietary fiber and ß carotene. The grain can be cooked in the same manner as rice

Value addition in foxtail millet

Foxtail millet has many food applications ie, porridge, pudding, breads, cakes, flour, chips, rolls, noodles making. Foxtail millet is fermented to make vinegar and wine in China and to make beer in Russia and Myanmar. Sprouted grains are eaten as vegetable (Brink, 2006).Have the highest mineral content, Comes in the form of rice, semolina and flour. Eaten commonly as *rice, roti, dosa, idli.* Hima Bindu and Sumathi (2003) prepared common Indian traditional products namely *muruku, chakodi, dosa, chapathi, laddu* and *payasam* by incorporating Foxtail millet. It was suggested that nutritious Foxtail millet could be exploited for the nutritional benefits and value added nutritive health foods.

Banyard millet

Barnyard millet called Sanwan in hindi and locally, is an important crop as it is a good source of slowly digestible carbohydrate, fair source of protein, excellent source of dietary fibre and minerals.

Value addition in barnyard millet

Veena *et al.* (2004) explored the substitution of Barnyard millet is used in five cereal based traditional foods viz., rice, *roti, dosa, idli* and *chakli*. Barnyard and finger millet based *khichadi, laddu* and *baati* were prepared along with legumes and fenugreek seeds by Arora and Srivastava (2002).

Proso millet

Proso Millet called Cheena in hindi, chikma locally – The grain has the highest protein content and very high in carbohydrates as well.

Value addition in proso millet

Proso-millet based convenience mix for infants and children was developed by Srivastava *et al.* (2001) by malting and popping techniques. Sweet and salt gruels, *halwa, burfi* and

biscuits based on the convenience mix were reported to be organoleptically acceptable.

Red rice (*Oryza nivara*)
Rices with a red bran layer are called red rices. Red rice is locally named as 'Bagdi chaur'. Red rices were highly valued as they had the power to redress the imbalance in the tridosha (the cornerstone of Ayurvedic medicine is the concept of doshas or the biological humors. (Ahuja, U. 2008). The red coloured pericarp in wild rices defines resistance to various biotic stresses and is used in many places for medicinal reasons (Sweeney and McCouch, 2007). Though the color is confined to the bran layer, a tinge of red remains even after a high degree of milling. The zinc and iron content of red rice's is 2–3 times higher than that of white rices (Ramaiah and Rao, 1953).Roasted red rice holds a good potential as a source of nutraceuticals in food formulations. (Mishra, V. *et al*. 2014). Red rice has a history of naturally dealing with a variety of health concerns, ranging from increased blood circulation to better digestion to eliminating blood blockages. Natural remedy for lowering total cholesterol, LDL levels and triglyceride levels, (according to Medline Plus).

Value addition in red rice
Value added products of Red rice are idli, dosa, utappam, pancakes etc which can add delicacy, nutrition in food basket. The red colour of red rice in Japan is now being used for making coloured noodles, cakes and alcoholic beverages (Patindol *et al*., 2006).

Value addition in underutilized crops
Roselle (*Hibiscus sabdarifa L*)
The calyces of Roselle (Hibiscus sabdarifa L) locally known as 'Bhenda phool' which grows well even when sown under rainfed conditions can be utilized for processing into different products. It is a very good source for coloring fruit products that don't have attractive color. Today, Roselle is attracting the attention of food and beverage manufactures and pharmaceutical concerns who feel it may have exploitable possibilities as a natural food product and as a colorant to replace some synthetic dyes.

Value addition in roselle
Many parts of Roselle including seeds, leaves, fruits and roots are used in various foods. Among them, the fleshy red calyces are the most popular. They are used fresh for making wine, juice, jam, jelly, syrup, gelatin, pudding, cakes, ice cream and flavors and also dried and brewed into tea, among other things. The red calyces contain antioxidants including flavonoids, gossypetine, hibiscetine and sabdaretine. Calyces are chopped and added to fruit salads, Stewed as sauce, syrup, jelly, lemonade like beverage are also made by the roselle.

Ash gourd (*Benincasa hispida*)
Ash gourd (Benincasa hispida), also known as wax gourd, white gourd or white pumpkin locally as 'Rakhia', is a popular vegetable, that were grown primarily for its use as a vegetable by the local tribes and usually recognized for its nutritional and medicinal properties. Harvested at both immature and mature stages, while young immature fruits are tastier when added in curries, fully mature fruits can be stored long.

Value addition in ash gourd
Both the immature fruits and mature fruits of ash gourd are used in a wide array of Indian dishes. The fruits are also used for making soup and sweetened fruit drink. Petha, the highly popular sweet with a delicious and absorbing taste is a translucent, almost clear candy prepared from ash gourd fruits. In India, ashgourd is used in curries or is coated with sugar or syrup and eaten as a sweet and recently Majumdar *et al*. (2009; 2010) have reported on the stabilization of ashgourd juice and ashgourd blended juice. However the fermentation process improves the quality in terms of nutrients and flavor. Therefore, an attempt has been made to develop fermented ashgourd beverage by optimization of the process with commercially available dry yeast and the study is oriented towards the analysis of nutritional profile of the product.

Value addition in indigenous pulses
Pulses are important source of dietary protein and have unique ability of maintaining and restoring soil fertility through biological nitrogen fixation as well as addition of ample amount of residues to the soil.

Rice-bean (*Vigna umbellata*)
Rice-bean (*Vigna umbellata*) called Sutari in hindi (locally as Jhurga) grown in the region,is an example of a underutilized species as the crop does not reflect its social value To date, it is little known, little researched and little exploited. Because of its high nitrogen content, the rice-bean provides an ecological service.

Value addition in rice-bean
Rice-bean is most often traditionally served as a dal, either soaked overnight and boiled with a few spices, or cooked in a pressure cooker. Apart from various recipes for dal soups and sauces, pulses are also used in a number of other ways, either whole, cooked or roasted, can be value added as flour, or ground to make various deep fried dishes or snacks, ready to eat product and as whole in improved packaging systems.

Field cowpea (*Vigna unguiculata*)
Field cowpea (*Vigna unguiculata* L.) commonly known as *lobia (*locally as jhurga*)* is one of the important *kharif* pulse crops grown for grain, forage and green manuring. Among all the grain-legumes, cowpea is the most extensively cultivated, distributed and traded food crop in India (Ogbo, 2009; Agbogidi, 2011; Philips and McWalters, 1991). Being rich in protein and containing many other nutrients, it is known as vegetable meat. On dry weight basis, cowpea grains are also rich source of calcium and iron.

Value added product of field cowpea
Field Cowpea is consumed as whole grain as well as *dal* or to make flour in variety of ways for table purposes. The crop is used in a variety of ways. Tender pods are used as vegetable and dry beans as pulse. Traditionally dried beans should be soaked for at least 8 hours in water, rinsed and cooked value added as ready to eat product and as whole in improved packaging systems.

Horse gram
Horsegram is called Kulthi in hindi and locally called 'kolath' This very small bean is little known but is one of food crop in

the region. It's eaten as whole beans, sprouts and meal, and noted for its distinctive earthy flavor. The horse gram is a cheapest source of protein, calcium and iron. A small amount may go into the recipe with the liquid. Horse gram cooking liquid is said to be useful for dissolving kidney stones but no medical studies seem to be available.

Value added product **of horse gram**

A common method of use is to boil the gram until done, drain off the liquid for human use and feed most of the drained gram to the livestock. value added products with buns with the incorporation of germinated horse gram flour to increase its protein content with acceptable organoleptic quality was studied by Chandralekha Bhokre *et al*, 2012. Horsegram flours could be exploited in the preparation and development of food products, such as bakery products, soups, extruded products and ready-to-eat snacks. The flours from these underutilized legumes may also be very attractive for producing composite flours (Yadahally N. Sreerama *et al*, 2011)

Value addition in indigenous fruits

Indigenous fruits can play an important role to in satisfying the demand for nutritious, delicately flavored and attractive natural foods of high therapeutic value. As the rich biodiversity of the region own a vast range of indigenous fruits of excellent flavor and color but however most of these fruits are underutilized. These fruits are sometimes, unappealing in the fresh form, but offer considerable potential for processing creating value-added products and marketing.

Custard apple (*Annona squamosa*)

Custard apple (*Annona squamosa*) called Sitafal in hindi, is fruit well known for its delicious taste are heart shaped with light green skin and a soft creamy white flesh. Custard apple is harvested in several instalments, but the best harvesting stage is when the firm fruit begins to develop colour. It is generally picked when it becomes creamy yellow between the segments and begins to crack slightly. The fruit has the tendency to burst open if kept on the tree for a long time. Custard apple is highly perishable and cannot be stored for long time. It can be stored successfully for 9 weeks at 7-10oC with 85% to 95% RH. Lower storage temperature induces chilling injury. Custard apple has a shelf life of 4 days after harvest, Cold storage or low temperature storage of the products is preferred (Sravanthi, 2014).

Custard apple Products

Custard apple is not used for processing purpose to a great extent. The pulp can be frozen successfully for use in ice-cream industry. Ready to serve beverages are made from custard apple. A simple technique has been developed for manual extraction of custard apple pulp by rotatory motion of a round hair comb in the scooped fruit held in stainless steel sieve. This pulp can be supplied to the ice-cream industries.Custard apples pulp provide sugars that give sustained energy and do not over react the body's insulin output like processed sugars. The sugars designed by nature are complemented by other natural products such as vitamins, minerals, fibre and protein necessary for energy production and can be used for preparing low fat ice creams **(** Gaikwad *et al*,2014) Custard apple milk shake has good potential to capture popularity due to its therapeutic and nutritive benefits. (**S**. P. Poul, *et al*, 2009). Custard apple is much relished by people due to its edible, soft, juicy, sugary granular and mildly flavoured pulp. It is also a good source of vitamin A and C. Its calorific value ranges from 822 to 1050 kcal per kg as compared with 741 kcal per kg of mango (Rao, 1974).

Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is known as 'Kathal' in hindi and 'Phanas' locally. The fruit is used both in the unripe and ripe stage. Raw jackfruit is popularly used as a vegetable. Fully mature but unripe fruits are harvested and appearance and a dull sound upon tapping judge fruit maturity.

Jack fruit products

Ripe jackfruit is consumed as a dessert fruit. Jackfruit chips are prepared by frying ripe or semi-ripe fruits. A palatable beverage concentrate can be made from jackfruit pulp by adding sugar, citric acid and water. In addition high class canned, frozen and dried products such as nectar, preserves confections etc. can be prepared from the ripe fruits. The green jackfruit utilized for making pickle, canned and curried vegetables. The wastes (skins, peels and cores), which constitute about 45% of the total fruit weight, have been found to be a fairly good source of pectin. Jackfruit srikhand from jackfruit bulbs has been developed and process was standardized. The pulp of ripe fruits (*rassal*) fruits can be preserved in tins and sold in Indian markets and also to ethnic population in international markets, also Kheer, Pappad, ready to cook products are made.(Technical bulletin no.41,ICAR Goa)

Aonla (*Emblica officinalies* Linn)

Aonla fruit is a sour and astringent in taste hence it’s not popular as table fruit. However this fruit is highly nutritious and is a rich source of pectin and polyphenols apart from ascorbic acid. The excellent nutritive and therapeutive value of fruit has great potential for processing into a number of quality products which can get a position in national and export market. Aonla is perishable fruit and it begins to spoil shortly after harvest. Aonla fruit is seldom consumed fresh but the fruit is valued highly in the Ayurvedic system of medicine.

Aonla products

Aonla jelly has been prepared using aonla juice, pulp and other ingredients like mango pulp, papaya pulp sugar and pectin. Aonla powder has been obtained using foam mat drying, Nutritional quality of foam mat dried aonla powder was superior as compared to simple aonla powder. The fruit can be processed into a number of value added products such as pickle, preserve, candy, jam, syrup breverages, squash and dried shreds.In Ayurvedic preparation like ‘Chyavanprash’ and triphala, A technique has been developed for separation of segments of aonla and do away with nut by steaming. These segments were used for preparation of different products of different varieties for processing into candy, murabba and pickle, the candy etc. Aonla dietary fibre-enriched biscuits and Aonla preserve is very important article of commerce and is in great demand.

Ber (*Zizyphus mauritiana*)

The fruit is of variable shape and size. It can be oval, obovate, oblong or round, depending on the variety. The flesh is white

and crisp. When slightly underipe, this fruit is a bit juicy and has a pleasant aroma. Lower temperatures increased the shelf life of the fruit, but chilling injury was a problem under 6 °C storage (Pareek.s, 2012)

Ber products

Ber fruit are consumed as such or can be processed into different fruit products. Juicy varieties are better suited for pulp and juice extraction. The fully ripe, well-developed fruits are washed de-stoned and juicer extracts juice. Ber juice can be used for the preparation of ready to serve beverage. Carbonated beverage of ber is highly acceptable and has excellent keeping quality. Dehydrated form is prepared by treating ber fruits with sulphur dioxide at 3.5-10 g/kg for 3 hours followed by sun drying, or carbinet drying below 15% moisture. Ber can be utilized for candy and ber pulp can be processed into wine. The steps include diluting the pulp, adding pectinase enzymes adjusting proper Brix with sugar, addition of yeast, fermentation, stabilization and clarification.

Jamun (*Syzygium cumini*)

The fruit is oblong, ovoid, starts green and turns pink to shining crimson black as it matures. The fruit has a combination of sweet, mildly sour and astringent flavour and tends to colour the tongue purple. It has a high source in vitamin A and vitamin C. The pulp of the fruit, extracts from the bark and seeds is of great benefit when it comes to lowering of blood glucose level. Taking dried extract of the seeds orally greatly reduces the blood sugar and glucosuria.

Jamun products

It is reported that jamun fruits are used for making products such as jam, jelly beverages, wine and vinegar. It has been found that maximum yield of jamun juice with a high level of anthocyanins. The jamun juice thus obtained is again heated to 85oC and then cooled to room temperature. Sodium benzoate (500 pm) is added to the juice before it is stored. Pure jamun juice can also be stored by heat pasteurization. The juice being highly acidic is not consumed as such. A ready to serve beverage (nectar) is prepared with 25% juice, 18o Brix and 0.6% acidity. Jamun seeds are also known for their properties which help to cure diabetes, diarrhea and dysentery.

Tamarind (*Tamarindus indica*)

The fruit of tamarind a pod 5 to 15 cm long, 3 to 10 seeds surrounded with edible pulp which is principal souring agent for sauces, chutney, in beverages and in general cooking. Pulp is carminative, laxative, given as infusion in biliousness and febrile conditions. It is also used in dyring and tanning and for polishing and cleaning metal ware.

Tamarind products

The tartaric acid is extracted from unripe fruits, they include tamarind paste, seedless dried tamarind, tamarind pods, tamarind concentrate, tamarind syrup, tamarind drink concentrate, tamarind sauce, tamarind chutney, tamarind dipping sauce, tamarind gelatin, tamarind candy etc. are the commercial value added products. Tamarind may also be used as a base for delicious raw or cooked chutneys, its fruity acidity combining well with sugar, chilli and other flavours, Moreover extensively used as an ingredient and an effective substitute for vinegar, tomatoes and lemon juice. Whole Pods are found piled (mostly broken) it is the least convenient form, otherwise prepared the same as for the block form, Pressed Block, most common form- pulp with the shell and most of the seeds removed, Concentrate (Regular Paste),Concentrate (Black) a highly concentrated and clearly has been cooked down, giving it a bit of a molasses flavor.

Diversification and Innovation in Value Addition

In the past, fruits and vegetables were processed primarily into jams, jellies, chutneys, etc. Canning and dehydration were considered to be the most sophisticated methods of processing, prior to the discovery of rapid freezing. Cold storage has considered the only method suited to extending the shelf life of fruits and vegetables, until the development of modified and controlled atmosphere storage. Relatively little emphasis was placed on the handling of fresh fruits and vegetables. In recent times, considerable emphasis has been placed on the handling of fresh fruits and vegetables. Canning has become practically obsolete and methods such as aseptic packaging, cryogenic freezing, deep freezing accelerated freeze drying, controlled and modified atmosphere storage, shrink wrapping etc. have been increasingly used in extending the shelf life of fruits and vegetables. These technologies must be adopted if India is to keep a pace with the rest of the World and are prepared at small scale as the knowledge about the merits of underutilized grains and indigenous fruits are limited to specific class of population.

Adding value to products can be accomplished through innovation and coordination. Innovation focuses on improving existing processes, procedures, products, and services or creating new ones. Industrial innovation is processing traditional food products into ready for consumer's uses.

Some of the successful intervention and innovation in value addition of food products:

(Source: ICAR Annual Report 2007–2008)

1. **Nanotechnology for antifungal paper:** Nanotechnology has the potential to transform food packaging materials in the future. Such nano scale innovation could potentially introduce many amazing new improvements to food packaging in the forms of barrier and mechanical properties, detection of pathogens, and smart and active packaging with food safety and quality benefits. The nano layer of aluminum that coats the interior of many snack food packages is one common example of the role that nanotechnology already plays in food packaging. A technology has been developed to produce zinc oxide nano particles using microbial approach. Nano zinc oxide imparted antifungal property to paper. Besides, nano zinc oxide-coated paper performed better compared to normal coating in brightness, whiteness, smoothness, print density and uniformity, picking velocity and oil absorbency.
2. **Mobile agro-processing unit for food grains and spices:** A mobile agro-processing unit for food grains and spices has been developed for demonstration in production catchments. The unit consists of a grain cleaner, two burr mills for grinding food grains and spices, a popcorn machine and a 7.5 kVA diesel generator for operating the machines. It is suitable for the primary processing in rural areas.

3. **Osmo-air dried Fruits**: Osmo air-dried fruits are based on a novel approach towards dehydration. Slices of ber, jackfruit, mango, etc. are processed in two stages. The osmo-air dehydrated product is near to the fresh fruit in terms of colour, flavor and texture. The process is simple and involves operations like selection of fruits, cleaning, washing, peeling, curing and slicing/ dicing. The prepared fruit slices are steeped in sugar solution to remove water by osmosis. The slices are then drained, dried in a hot air drier and packed in flexible pouches. The product can be used in ready -to –eat type foods, ice cream, fruit salad, kheer, cakes and bakery products. Such osmo-air dried fruit based units can be set up in areas near fruit orchards to the benefit of people.
4. **Enhancing shelf-life of fruits:** Shelf-life of fruits could be extended by 5 weeks at 8°C in unripe hard green condition without any chilling injury by bulk packing (4 kg box) in 100-gauge D-955 or PP film with 0.0125% micro-perforations.
5. **Ready to cook and Ready to eat products**: Significant achievements have been recorded in packaging technology for milled rice for ready-to-cook applications in domestic market and export. Quick cooking rice has been developed at DFRL and CFTRI, Mysore. The technology is being used for making available food supplies to defence personnel in boarder areas under war or war like situations. Rice is partially cooked and packed under highly sanitary conditions. It is autoclaved and supplied for safe use upto 6 months of period.
6. **Wax Emulsion for Fruit & Vegetables**: A large number of units in tiny sector can be set up for improving the shelf life of fresh fruits and vegetables in villages where they are grown for marketing in the urban areas. The wax emulsion is diluted with cold water and used for dipping fruits and vegetables. It enhances the shelf life, protects fruit from fungal attack, and reduces desiccation and weight loss during storage. The emulsion is harmless and imparts a gloss to fruits and vegetables. The process is quite simple and economical.

Conclusion

Bastar region has a great diversity of indigenous plants and underutilized crop species. These species have enormous nutritional, medicinal, and economic values and when promoted, could highly contribute to poverty reduction mainly in rural areas, and to the improvement of both nutritional and health status of the local populations. For the promotion of these indigenous plants and underutilized crop species, it will be important to put in place a national and special research and development programme under the joint umbrella of the government involving all the possible actors including researchers, developers, and producers. Keeping in view the great potential of aforementioned crops and plants in Bastar women self-help groups can establish small scale industry or processing units. Publicity, awareness campaigns and training are important and innovative approaches of popularization which will help in capturing the market share. Policy makers are to be sensitized on health and nutritional benefits of processed millets and wild foods on target populations such as school children-midday meal scheme and poor social groups-PDS system and health-conscious consumers.

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