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**Double sweet potato grower's income through  
value addition**

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**Abstract**

Bokaro district is famous as vegetable belt in Jharkhand state. In vegetable crops, among Root & Tuber group, sweet potato is major crop and heavily produced in Bokaro. In spite of heavy production, sweet potato growers are economically poor because they are forced to sell their produce at very low price i.e. maximum at the rate of Rs 8 to 10 per Kg. The primary reason behind this situation is our farmers have no knowledge about value addition or processing of sweet potato even at home scale basis. That's why sweet potato remains still an unexploited crop. When sweet potato is rich source of carbohydrates, starch, fibre, vitamins and minerals. So, it can be an important tool for tackling malnutrition and micronutrients problems in weaker section of the society. By keeping these points in consideration, an OFT was conducted in KVK, Bokaro, in which three treatments were taken, first as Farmers Practice (FP), second and third as Technological Option: I (T.O.I) and Technological Option: II (T.O.II). In F.P, farm women consume sweet potato just after boiling whereas in T.O.I and in T.O.II, farm women used sweet potato based nutritious and composite flour with different composition as formula I and formula II. After preparation of sweet potato based nutritious and composite flour having formula-I and formula-II, nutritive value, sensory evaluation, grading and cost analysis of all three treatments were done. Result of the OFT shown that T.O.I i.e. sweet potato based nutritious and composite flour having formula-I was found highest in nutritive value and in all six parameters of sensory evaluation (appearance, colour, texture, flavour, taste and overall acceptability). When laddoo and puwa was prepared by the use of this sweet potato based nutritious and composite flour having formula I, was liked very much by the farm women. Regarding cost, raw sweet potato price in local market is Rs 8 to 10 per Kg which is too low at present time whereas cost of sweet potato based nutritious and composite flour was Rs 70 per Kg and its shelf life is about three months at room temperature when kept in ordinary jar in home. Its preparation and processing is also very simple which farm women can do by their own at their home scale basis. Therefore, on one side, it is very good source of income for them and on other side, it will act as an important tool for eradication of malnutrition and micronutrients deficiency in rural areas especially among small children and reproductive women.

**Keywords:** Sweet potato, beta-carotene, nutritive value, processing, value addition

**Introduction**

Bokaro district of Jharkhand state is famous for vegetable cultivation. In vegetables, among Roots & tuber group, sweet potato is major crop and heavily produced in Bokaro. In two block of Bokaro district name as Petarwar and Kasmar block approximate 2700 metric tones was produced in 2018 year and it is cultivated in approximate 80 to 90 hectares of land. It is vegetatively propagated through planting material (cuttings from vines) therefore easily shared among farmers. It is low input and also drought tolerant plant. So, this crop is very suitable for Jharkhand like state where irrigation facility is not available for most of our farmers, also in Bokaro district.

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On an average, productivity of sweet potato from 2016 to 2018 is approximate 25 to 30 tones per hectare (Birsa Kisan Diary, 2018). But sweet potato growers are economically poor. Because they grow sweet potato in bulk amount but they sell it at very low price i.e. hardly at the rate of Rs 8 to 10 R per Kg. That's why they are still poor. Sweet potato is among the world's most important and under-exploited food crops. With more than 133 million metric tonnes in annual production, sweet potato currently ranks as the fifth most important food crop in developing countries after rice, wheat, maize and cassava (Scott and Maldonado, 1999; Grant, 2003)<sup>[12, 8]</sup>. Sweet potato consumption has been adjudged to decline as income rise- a change often linked with urbanization, partly because it is perceived as a poor man's food but mostly because of the lack of post-harvest processing or storage (FAO STAT, 2008)<sup>[3]</sup>.

### Global Production Status of Sweet Potato

Sweet potato is an important root crop grown all over the world and consumed as a vegetable. United Nations Food and Agriculture Organization (FAO) (2011)<sup>[5]</sup> reported that sweet potato (*Ipomea batatas* (L.) Lam) is a very important crop in the developing world. According to FAO (2011)<sup>[5]</sup>, sweet

potato is one of the seven crops in the world produce over 15 hundred million metric tonnes of edible food among the root and tuber crops. China is the world's largest sweet potato producing country, producing 71 million tons annually. China alone produced 8 to 85% of the total sweet potato production in the world while the remaining countries in Asia have the next highest production and then, followed by Africa and Latin America (...2009).

**Production Status of Sweet Potato in India:** Horticulture sector has become one of the major drivers of the growth in agriculture sector. Horticulture sector provides employment opportunities across primary, secondary and territory sectors. Vegetables are mostly grown by small and marginal farmers and augment income of farmers. This sector also enables the population at large to enjoy a diverse and balanced diet for health living. Our presence in the global market has been growing. Production of fruits and vegetables has overtaken the production of food grains in the country. It is matter of pride that India is the second largest producer of vegetables and fruits in the world (nhb.gov.in/statistics/publication cited on 3/12/2019).

**Table 1:** Major State-wise Area and Production of Sweet Potato in India Area in '000Ha Production in '000MT

Sl. No.	States	2015-16		2016-17		2017-18	
		Area	production	Area	production	Area	production
1.	Odisha	40.84	385.55	40.40	381.11	40.41	381.004
2.	Kerala	20.82	338.54	19.86	319.77	20.87	341.02
3.	West Bengal	22.71	239.81	22.71	240.62	20.40	2200.44
4.	Uttar Pradesh	17.07	225.87	17.24	228.36	17.33	229.59
5.	Maharashtra	0.54	12.84	3.44	51.29	3.51	43.56
6.	Chhattisgrh	3.69	38.23	4.03	41.62	4.29	45.04
7.	Bihar	0.90	8.40	0.90	8.49	1.04	8.51

**Source:** Horticulture Statistics Division, Department of Agriculture, Coopn & Farmers Welfare

### Sweet potato as source of food security

Sweet potato fulfils a number of basic roles in the global food system, all of which have fundamental implications for meeting food requirements, reducing poverty and increasing food security because sweet potato is a cheap calorie producer and is rich in vitamin A and C and minerals. It could be a very good vehicle for addressing some health related problems. Sweet potato processing is essential because a lot more in sweet potatoes than its starch. The processed products made from sweet potato not only compete with cereals but also with each other processed products in terms of market and raw materials. Declining availability of rice, population growth, modest absolute income levels for large segments of consumers, and declining farm size will contribute to a growing use of fresh roots, and in certain areas for human consumption. It was established that consumers prefer processed products of roots such as noodles to fresh roots (Scott *et al.*, 2000)<sup>[11]</sup>. So, it could be a very good vehicle for addressing food security. Available evidences suggested that postharvest processing and subsequent storage of sweet potatoes is needed for industrial and export purposes.

### Nutritive value of sweet potato for Human

Nutritional composition of sweet potato which are important in meeting human nutritional needs including carbohydrates, fibres, carotenes, thiamine, riboflavin niacin, potassium, zinc, calcium, iron, vitamin A and C and high quality protein. Sweet potato particularly provides energy in the human diet in the form of carbohydrates. Sweet potato is a very efficient

food crop and produces more dry matter, protein and minerals per unit area in comparison to cereals (Woolfe, 1992)<sup>[14]</sup>. Apart from being a rich source of starch, sweet potatoes contain good quantity of secondary metabolites and small molecules which play an important role in a number of processes (Friedman, 1997)<sup>[2]</sup>. Many of the compounds present in sweet potato are important because of their beneficial effects on health, therefore, are highly desirable in the human diet, functions as a functional food (Katan and De ROOS, 2004)<sup>[9]</sup>. According to USDA (2009)<sup>[13]</sup>, besides carbohydrates, they are also rich in dietary fiber and have high water content and also provide 359 kJ energy with low total lipid content, which is only about 0.05g per 100g. In addition, sweet potatoes also are high in minerals such as potassium, calcium, magnesium, sodium, phosphorus and iron (USDA, 2009)<sup>[13]</sup>. Because of the various roles that sweet potatoes play around the world, the concept of nutritional quality and its contribution must transform to meet specific roles in human diet.

### Need of Processing and Value Addition of Sweet Potato

The global situation of sweet potato as a commodity is that it is widely grown throughout the world. However, only about one per cent of production enters world trade. Most of the product is used for table consumption with a small percentage going into industrial uses. The traditional methods of processing sweet potato in most countries have been limited to washing, peeling and boiling. Some farmers makes chips, sundry, store and later reconstitute by adding water then cook

by boiling. Others dry the grated product, mill and then add to other flours to make composite flours. FAO (2011) [5] developed improved processing methods to help overcome some of the problems associated with traditional method, in order to produce sweet potato flour with improved odour, colour and nutritional qualities. The development of processed products from sweet potato presents one of the most important keys to the expanded utilization of the crop. Just like white potatoes research and development (R & D) has transformed the crop from a simple staple food to an important commercial crop with multiple uses such as a snack. Lopez *et al.*, (2000) [10] reported that sweet potato flakes with an increase beta-carotene content were produced in Guatemala to conquest vitamin A deficiency in children.

By considering all these points, an On Farm Trial (OFT) was conducted at KVK, Bokaro district with the objective of development of sweet potato based nutritious and composite flour which can be used in the preparation of different kind of sweets like Puwa, laddoo and halwa due to having sweet in taste.

### Methodology

By considering heavy production of sweet potato in Bokaro district and its un-exploitation as well as low earnings of the farmers after selling of sweet potato, an On Farm Trial was conducted at KVK, Bokaro with the objective to increase the sweet potato growers income. In OFT, three treatments were taken. First as Farmers Practice (FP) in which farm women use or consume sweet potato traditionally just by boiling or roasting. In the local areas, the general method of sweet potato consumption was either by boiling or by roasting. In second and third treatments, which was known as Technological Option. I (T.O.I) and Technological Option: II (T.O: II) in which sweet potato based nutritious and composite flour was developed with different composition known as Formula-I and Formula-II.

**Table 2:** Composition of Sweet Potato Based Nutritious and Composite flour

Sl. No.	Formula-I:	Formula-II:
1	Sweet potato flour=66%,	Sweet potato flour=50%,
2	Bengal gram dal flour(besan)=20%,	Bengal gram dal flour(besan)=20%,
3	wheat flour=8%,	wheat flour=24%,
4	Refined oil-6%	Refined oil -6%

**1. Steps of preparation of sweet potato based nutritious and composite flour:** In the preparation of sweet potato based nutritious and composite flour, a sequence of steps were conducted which is given below.

- 1. Purchasing of purple skinned sweet potato from local market:** In the local market, three types of sweet potato was available. Local people liked purple skinned sweet potato more as compared to two other type of sweet potato due to having more pleasant colour, sweetness and tasty. The amount required for the study was purchased from the local market.
- 2. Washing, peeling and slicing of fresh sweet potato:** Each and every sweet potato was thoroughly washed. All unwanted part were removed and then sliced with the help of chips cutter by putting over a big topiya filled with water containing salt (2%) for better colour retention and whiteness of the chips.
- 3. Chips making process from sweet potato:** All sweet potatoes were sliced into chips so that it can be easily and

evenly sun dried. Due to even size of chips, it was sun dried almost in same duration of time.

- 4. Soaking of sweet potato chips in normal water:** All sweet potato chips were soaked for 90 minutes in normal water containing salt (2%). This process has two advantages, first it helps in better retention of the colour and second, chips have almost equal moisture content as compared to without soaking.
- 5. Sun drying of sweet potato chips:** After 90 minute soaking in salt containing normal water, chips were kept for sun drying. It sundried in two to three days.
- 6. Milling of sundried sweet potato chips into flour:** After complete sun drying, all sweet potato chips were kept in plastic jar and given for milling for flour making.
- 7. Preparation of nutritious and composite flour by adding other ingredients:** After flour making from sweet potato chips, it was blended with other essential ingredients like Bengal gram flour (besan), wheat flour and refined oil to prepare nutritious and composite flour. Since, sweet potato is rich source of carbohydrates and starch but contain very less amount of fat so fat was added additionally so that nutritive value and the taste of final product must be good. Sweet potato contains quality protein but in very low quantity that's why besan or Bengal gram flour was used in the composite flour. The function of wheat flour was of binding material in the composite flour. In both, Formula-I and Formula-II, same ingredient were used but with different quantity.

**2. Calculation of Nutritive value of sweet potato and its composite flour:** Nutritive value of sweet potato used in the Farmers Practice (FP) and sweet potato based nutritious and composite flour were calculated with the help of book titled as The Nutritive Value of Indian Foods (Gopalan, 2004) [7] as per the ingredients used in all three treatments. In Farmers Practice, only sweet potato was used whereas in T.O.I and in T.O.II, ingredients used were sweet potato, bengal gram flour (besan), wheat flour and refined oil. So, nutritive value were calculated as per the amount used in the preparation of sweet potato based nutritious and composite flour.

**3. Sensory evaluation through score card method of sweet potato & its product:** In the present study, sensory evaluation was done with the help of score card method. Score card method was selected for conducting sensory evaluation because farm women were either illiterate or very less educated for conducting 9 Point Hedonic Scale or 5 Point Hedonic Scale. Scoring was done in the form of number range so that it will help farm women in giving numbers to the concerned technical parameters. In technical parameters, appearance, colour, texture, flavour, taste and over all acceptability were taken. Sensory evaluation was done on the date of preparation of boiled sweet potato and PUWA prepared from sweet potato based nutritious and composite flour.

### Score Card Method of Sensory Evaluation

For the acceptance of any food produce in the market or commercially, it is very essential to do sensory evaluation through a large number of people of that particular product. There are so many methods of sensory evaluation like 9 Point Hedonic Scale or 5 Point Hedonic Scale. But, since most of the farm women were either illiterate or very less educated. That's why Score Card Method was used in the study. In Score Card Method, scoring was done on quality

characteristics of the product in whole numbers not in decimals using score scale given below.

Scoring scale: 1-2 Very poor, 3-4 Poor, 5-6 Fair, 7-8 Good, 9-10 Very good

**Table 3:** Score Card Method of Sensory Evaluation used in the study

Product code	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
Maximum Score	10	10	10	10	10	10
Farmers Practice(FP)						
T.O.I						
T.O.II						

**4. Shelf life analysis of sweet potato and its nutritious and composite flour:** Shelf life were analysed by observing its appearance, colour, flavour, taste and Overall acceptability of the boiled sweet potato and the product(PUWA) developed from both sweet potato based nutritious and composite flour Formula-I and Formula-II.

**5. Cost analysis of all three produce of the study:** Cost analysis of all three produce of the study were done. Price of fresh purple skinned sweet potato was in the local market was Rs 10 per Kg. In general, local people consume sweet potato just after boiling or roasting in residual fire left at the end of meal preparation. Cost analysis of sweet potato based nutritious and composite flour having Formula-I and Formula-II was done by considering the price and the amount of all raw ingredients used in the preparation of flour. In Formula-I, and in Formula-II, raw ingredients used were same i.e. sweet potato flour, bengal gram flour(besan), wheat flour and refined oil. Variation was in their quantity only which differed their cost.

**6. Preparation of PUWA from sweet potato based nutritious and composite flour:** After preparing sweet potato based nutritious and composite flour Formula-I and Formula-II, a widely consumed religious food product i.e. PUWA was developed. Then, sensory evaluation was

conducted among boiled sweet potato and PUWA developed from composite flour Formula-I and Formula-II. After some time, laddoo was developed from same composite flour at the end of three months, which was also liked by farm women.

### Result & Discussion

After finishing all procedure mentioned in the methodology of the study, findings are given in tables and discussed in detail one by one below.

#### Nutritive value of sweet potato and composite flour

Any food produce is accepted in the market on the basis of nutritional composition it contains. So, it was very essential to calculate its nutritive value of the developed food produce.

Nutritive value of sweet potato used in the Farmers Practice (FP) and sweet potato based nutritious and composite flour Formula-I and Formula-II were calculated with the help of the book having title as "The Nutritive Value of Indian Foods by (Goplalan, 2004) [7]" as per the ingredients used in all three treatments. In Farmers Practice, only boiled sweet potato was used whereas in T.O.I and in T.O.II, sweet potato based nutritious and composite flour Formula-I and Formula-II were used, in which same ingredients were used e.g. sweet potato, bengal gram flour( besan),wheat flour and refined oil but in different quantity. Nutritive value were calculated and given in Table no.4.

**Table 4:** Nutritive value of the food produce belonging to all three treatments (per 100g)

Nutrients Treatments	Protein (g)	Fat (g)	CHO (g)	Energy (Kcal)	Calcium (mg)	Iron (mg)	Beta-carotene (µg)	Vitamin-C(mg)
FP	1.20	0.3	28.2	120	46	0.21	6	24
T.O.I	9.42	8.16	110.29	551.08	167.24	2.98	89.72	79.2
T.O.II	10.40	8.19	98.83	1509.64	138.12	3.60	89.56	60

After calculating the nutritive value of all three food produce, it was found that boiled sweet potato had least protein, fat, carbohydrates, energy, calcium, iron, beta-carotene and vitamin-C among all the three treatments. Whereas sweet potato based nutritious and composite flour having Formula-I had highest in nutritive value and Formula-II had second highest in nutritive value except in case of energy (551.8 Kcal in Formula-I). In energy, sweet potato based nutritious and composite flour Formula-II (159.64Kcal) was found best. In this way, it could be said that Formula-I was found best from

nutritional composition point of view when all three produce were compared.

#### Sensory Evaluation of sweet potato and its product developed from nutritious and composite flour

Sensory evaluation is used to know the choice of the people and response regarding any newly developed food product in the market. It helps in deciding the future of that particular product in commercial world.

**Table 5:** Mean Value of parameters of sensory evaluation of food produce on the date of preparation

Parameters Treatments	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability	Overall grading
FP	6.12	5.87	5.75	5.25	7.75	6.75	3rd
T.O.I	8.62	8.75	8.62	8.87	8.75	8.50	1st
T.O.II	7.25	7.12	6.87	6.87	6.75	7.25	2nd

After calculating the nutritive value of all three food produce belonging to the treatments, sensory evaluation was done with the help of score card method. Score card method was used because it was comparatively easier for farm women. In

Farmers Practice (FP), only boiled sweet potato was consumed whereas in T.O.:I and in T.O.:II, PUWA developed from sweet potato based nutritious and composite flour Formula-I and Formula-II were consumed. Sensory

evaluation was done by farm women involved and they scored the product as per their decision. In the assessment of sensory evaluation, it was found that PUWA developed by the use of sweet potato based nutritious and composite flour having Formula-I was found best in appearance, colour, texture, flavour, taste and overall acceptability and PUWA developed by the use of Formula-II found second in position. Finally, PUWA prepared by the use of Formula-I was found with best quality in all parameters mentioned above and it was graded as first.

**Table 6:** Shelf life and cost of food produce belonging to all three treatments.

Treatments Parameters	Farmers Practice	Sweet potato based Formula-I	Sweet potato based Formula-II	Remarks
Shelf life	Hardly one day	In good condition even at the end of December (whereas harvested in Oct-Nov)	In good condition even at the end of December (whereas harvested in Oct-Nov)	Hardly after one month raw sweet potato develops undesirable change in taste and in flavour. But, in both composite flour had no such negative effect in any kind of six parameters of sensory evaluation.
Cost per 100 g	1.00	6.50	7.00	

**Note:** Cost of jar in not included in Cost per 100 g

After the assessment of shelf life, it was found that shelf life of boiled sweet potato was hardly one day and raw sweet potato can be used for normal consumption for one month. It is general practice of the local farmers that they kept sweet potato in their home for two to three month for their normal consumption, but in this period sweet potato develops some undesirable changes in sweet potato like in taste and in flavour. Whereas sweet potato based nutritious and composite flour can be used continuous for three months. Even at the end of three month both, sweet potato based nutritious and composite flour did not developed any undesirable changes like in taste and flavour. It was in good condition in all six parameters of sensory evaluation. Both sweet potato based nutritious and composite flour Formula-I and Formula-II were in good condition even at the end of three months, when sweet potato was harvested in Oct-Nov, both sweet potato based nutritious and composite flour Formula-I and Formula-II have pleasant aroma and good flavour at the end of December. When both composite flour were kept in plastic jar at room temperature in their home.

#### Cost analysis of all three produce of the treatments

For wider acceptance of any food produce, it is very essential that its price should be within reach for larger section of the society. In rural areas the food produce should be of low cost because the economic condition of most of the farming community is not sound.

In the present study, the cost of sweet potato in the local market was Rs10 per Kg which was responsible for poor economic condition of the farmer. But, when cost analysis of sweet potato based nutritious and composite flour Formula-I and Formula-II was done, it was calculated as Rs 65 per Kg and Rs 70 per Kg which was much better as compared to raw sweet potato. The method of sweet potato based nutritious and composite flour preparation was simple and easy for farm women. Most important, it was "ready to use" supplemental composite flour or food produce due to being easily digestible both for small children and for reproductive, the most malnourished section of the society.

#### Conclusion

Sweet potato is major crop and heavily produced in Bokaro but, is still unexploited due to lack of its processing and value addition knowledge and farmers are compelled to sell it at very low price. Whereas, it is rich not only in carbohydrates

#### Assessment of shelf life of all three produce of the treatments

Assessment of self life of any food produce is essential so that it can be assured that till what period that particular product could be consumed safely. With this purpose, shelf life of boiled sweet potato and sweet potato based nutritious and composite flour having Formula-I and Formula-II was assessed.

and starch but also have lots of fibre, vitamins and minerals. But, it contains very small amount of fat. So, it could be a very good vehicle for addressing some health related problems and as a source of food security. Now, there is urgent need of sweet potato processing and value addition because it may be a very good source of income for farming community. In this way, it can be concluded that sweet potato's processing and value addition is the way to make dream of farmers true to double their income in real sense.

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