ONLINE ISSN 2583-4339
www.journalworlds.com

Agri JOURNAL WORLD

Volume 2 issue 10 October 2022 Pages 41

PUBLISHED BY LEAVES AND DEW PUBLICATION

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

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Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

Published By

LEAVES AND DEW PUBLICATION

B- 132, Nanhey Park,

Uttam Nagar, New Delhi 110059

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

CONTENTS

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

SOLANUM NIGRUM: LOST IN THE MIDST OF WEEDS

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ABSTRACT

Exploring the potential of underutilized leafy vegetables is much required for the current scenario. Changing traditional food habits increases the usage of underutilized leafy vegetables providing more nutritious food. Solanum nigrum is considered as medicinal plant apart from being used as a leafy vegetable. This plant has been extensively used in traditional folk medicine to treat various diseases. The proximate analysis of the leaves of Solanum nigrum shows that it is a rich source of proteins, fibre and minerals. Solanum nigram being nutritionally rich, can be added to our daily diet to overcome many nutrient deficiencies and the inclusion of locally grown food provides sustainable nutrition security.

INTRODUCTION

We come across many leafy vegetables around us, whether on the farm or in the kitchen garden. Even though leafy vegetables are included in our daily diet still, many leafy vegetables are not explored, and thus they are still underutilized. Our ancestors were well acquainted with these underutilized green leafy vegetables due to their nutritional quality and medicinal properties. But as the food habit and crop cultivation is changing, these leafy vegetables are neglected. Owing to the current scenario of leading healthy lifestyle with emphasis on traditional food habits, these underutilized leafy vegetables play a major role. Among underutilized leafy vegetables, *Solanum nigrum* is not yet exploited its potential in terms of nutrition and medicinal properties.

Solanum nigrum, a native plant of India, belongs to the family Solanaceae, commonly called night black shade and its local name in the Indian Himalayan region is Makoi. It is called as ganake soppu (kannada), manatakkali (tamil), mokoi (hindi), mulaku thakkali (malayalam), kasaka (telugu) (www.flowersofindia.net). It generally grows as a weed. It has been used in

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

ethnomedicine to treat diabetes as a hepatoprotective agent and lactagogue and is believed to have various biological properties. Even though it has been used as a leafy vegetable in India, it is still considered underutilized as it is not cultivated commercially like other leafy vegetables. However, its fruits are also edible and are consumed as fresh.

NUTRITIONAL PROPERTIES AND BIOACTIVE PRINCIPLES PRESENT IN *SOLANUM NIGRUM* LEAVES

Many studies have been done to explore the nutritional quality of this plant. The proximate analysis of the leaves of *Solanum nigrum* shows that it is a rich source of proteins, fibre and minerals (Table 1). Liv.52, an Ayurvedic herbal preparation containing several herbs, including *Solanum nigrum,* was given to stimulate appetite in children to overcome malnutrition due to anorexia. Improvement in appetite in the Liv.52 consumed group was observed, resulting in increased food intake. Both body weight and height started showing significant improvements after a month and continued throughout the study in the treated group. Because of the high nutritional quality of *Solanum nigrum*, it is beneficial to include these leafy vegetables to get balanced nutrition and to address micronutrient deficiency among vulnerable groups such as children, adolescent girls, pregnant women and elders.

A pic of *Solanum Nigrum*

Solanum leaves are not only rich in proximates. Many studies on extracts of leaves of *Solanum nigrum* showed that leaves also contain an appreciable amount of bioactive compounds such as phenols, flavonoids, carotenoids and others. When leaves were extracted with different solvents such as acetone, methanol and water extracts, it was found that the leaves

of *Solanum nigrum* had a total polyphenol content of 9.64 mg/g of dry plant material, total flavonoid content of 1.41 mg/g of dry plant material, proanthocyanidins content of 2.10 mg/g

Table 1: Proximate and minerals content of the leaves of *Solanum nigrum*

Constituents	Quantity %
Moisture	68
Ash	13
Protein	18.2
Fat	8.5
Carbohydrate	37.2
Crude fiber	23.1
Energy (Kcal)	298
MACRO AND MICRO MINERALS	**MG/100G DRY WEIGHT BASIS**
Magnesium	246
Calcium	17.33
Potassium	41.69
Phosphorus	75.22
Sodium	2.90
Iron (ppm)	13.01
Zinc (ppm)	0.09
Copper (ppm)	16
Manganese (ppm)	1.52-83
Sulphur	8.55

Source: Jimoh *et al.*2010; Akubugwo *et al.*2007

of dry plant material and total flavonol content of 0.68 mg/g of dry plant material (Jimoh *et al.*, 2010). The phenols present in leaves have been shown to have antioxidant activity. Apart from these compounds, a high amount of total carotenoids, which is a precursor for vitamin A (35.25 mg/100g edible portion) and β-carotene (14.05 mg/100g edible portion), was found in leaves with retinol equivalent of 2.34 mg/100g edible portion (Rajyalakshmi *et al.*, 2001). This shows that the leaves act as a very good source of vitamin A, which is essential for vision, skin and other metabolic activities in humans.

THERAPEUTIC PROPERTIES OF *SOLANUM NIGRUM* LEAVES

Solanum nigrum is considered a medicinal plant from being used as a leafy vegetable. This plant has been extensively used in traditional folk medicine to treat various diseases. The extracts of these plants have been reported to contain many polyphenolic compounds which show antioxidant activity. The leaves were shown to inhibit oxidative DNA damage. However, the effect was dependent on the concentration of leaf extracts.

Studies on human cancer cell lines in the laboratory have shown that leaf extract showed a cytotoxic effect on human cancer cells. Thus *S. nigrum* can become a promising cytotoxic agent against the selected cancer cell lines. The diet containing cooked leaves of S. nigrum increased the concentrations of essential amino acids and other nutrients in the rats. The study concluded that adding *S. nigrum* to the diet improves the quality and quantity of some nutrients such as vitamin C, β-carotene, protein and amino acids, which probably favour an increase in the activity of liver drug-metabolizing enzymes. *Solanum nigram* leaves and fruits can treat different types of anaemia and boost the immune system.

CONCLUSION

Exploring the potential of underutilized leafy vegetables is much required for the current scenario. Moving towards traditional food habits increases the usage of underutilized leafy vegetables providing more nutritious food. Apart from that, the medicinal properties help mitigate many diseased conditions at the initial level. *Solanum nigram* being nutritionally rich, can be added to our daily diet to overcome many nutrient deficiencies and the inclusion of locally grown food provides sustainable nutrition security.

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Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

LAC CULTIVATION: AN OPTION FOR LIVELIHOOD SECURITY IN ASPIRATIONAL DISTRICTS OF INDIA

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ABSTRACT

Raw lac is the source of three valuable products, i.e. resin, dye and wax. Lac cultivation is an important source of income for the livelihood of the forest and sub-forest dwellers of different Indian states. Lac production is a highly labour-intensive process and employs both men and women dwelling in forest and sub-forest areas of these states. It is a highly remunerative crop, paying high economic returns to the farmers and foreign exchange of the country through its export. With the recent policy interventions by the government there is abundant opportunity for entrepreneurs as well as farmers to operate the lac production and have the livelihood security.

INTRODUCTION

Millions of people around the Earth depend on forests for medicine, raw materials, fuel, income and food. Food and Agricultural Organization (FAO) reports that about 500 million people inhabit in or near forests, and in some places, forests are the primary source of food supply. But forests supplement people's diets almost everywhere, particularly in lean seasons. In many developing countries, forest foods represent a much-needed safety net, helping people get by between harvest seasons, when crops fail or during droughts, famines or social strife. In some areas, forests support livestock production by providing fodder, and in others, for example, coastal mangrove swamps – they support local fisheries.

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

Forest ecosystems supply many important products and services to society. Wood is a key forest product, but many other forest products exist. These products are often called Non-Wood Forest Products (NWFPs). The global demand for NWFPs has increased due to the current trends in lifestyle and consumption. Consequently, the commercial utilization of NWFPs is increasing in World forestry. Timber-oriented Forest management is transitioning towards sustainable joint-production of timber and NWFPs and maintenance of other ecosystem services. Different types of NTFPs differ in abundance, ecology, origin, yield periodicity, harvesting rights, frequency and methods, end-use and economic importance. Further, domestication varies considerably, from opportunistically collected wild resources to products actively enhanced or cultivated.

NWFPs are utilized on a small and medium enterprise level but can also frequently be found as internationally established mass-market products. The identification and ecology of NWFPs concern recognizing a species to use as an NWFP and the specific conditions that the resource requires within the forested environment to flourish. Over past decades the increased utilization and production of NWFPs have ensured that Natural Resins and Gums (NRGs) represent one of the principal NWFP groups within Indian forests and have an immense role in the livelihood security of tribal communities due to their high economic and social and ecological value.

NATURAL RESINS– A FAUNA (*KERRIA LACCA* (KERR)) BASED RESIN

Kerria lacca (Kerr), an Indian lac insect which thrives on the tender twigs of specific host trees *viz.*, *palas* (*Butea monosperma*), *ber* (*Ziziphus mauritiana*), *Kusum* (*Schleichera oleosa*), *Flemingia semialata*, *Ficus spp*. *etc.* secretes resin (known as lac). It is cultivated mainly by the tribal communities and the forest dwellers in India collect a little quantity. *Rangeeni* and *Kusmi* are the two strains of lac insect which are classified based on the preference of the insect for specific host plants. Raw lac is the source of three valuable products,

Photo 1. The encrustation of natural resins in the exhibition pavilion

i.e. resin, dye and wax. Lac cultivation is an important source of income for the livelihood of the forest and sub-forest dwellers of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha and parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region. Lac production is a highly labour-intensive process and employs both men and women dwelling in forest and sub-forest areas of these states. It is a highly remunerative crop, paying high economic returns to the farmers and foreign exchange of the country through its export. Lac is mainly produced in India, Thailand, Indonesia, and other parts of China. India is the largest producer of lac in the world.

LAC PRODUCTION IN INDIA

Tree species in agro forestry are very important and vital for lac cultivation. It reflects the choice of farmers and, in some sense, market demand. There are 49.2 crores of *palas* (*Butea*

Table 1. Current use of existing resource base for lac cultivation and the possibility of employment generation across disadvantaged areas in India.

Particulars	*Butea monosperma*	*Ziziphus mauritiana*	*Schleichera oleosa*	Total
Total number of lac host trees (in millions)	491.70	93.00	36.70	621.40
Number of lac host trees excluding the 33% forest reserve (in millions)	163.90	31.00	12.23	207.13
Number of available lac host trees/annum (in millions)	54.63	10.33	2.45	67.41
Number of lac host trees used for lac cultivation (in millions)	10.50	3.44	1.37	15.31
Per cent Utilization	19.22	33.30	55.80	22.70
Employment generation on current use (million human days)	28.35	16.51	5.80	50.67
Employment generation on potential use (million human days)	147.51	49.60	10.40	207.51
New employment opportunities (million human days)	119.16	33.09	4.60	156.84
Total population of major lac producing states (in millions)	NA	NA	NA	377.00
All India population (in millions)	NA	NA	NA	1210.19

Source: *Forest Survey of India Report 2013; 15th National Census Survey, 2011; NRG Information Cell, ICAR-IINRG, Ranchi, 2013.*

monosperma), 4.5 crores of *ber* (*Ziziphus mauritiana)*, and about 3.7 crores of *Kusum (Schleichera oleosa)* stems spread in various Agro forestry Systems over the country (FSI, 2017), which is about 3% of the total number of available trees. India has about 621.4 million lac host trees, and not more than 5% of this huge inoculable area is utilized for production (Table 1). Recently, the Government of India has initiated the Minimum Support Price (MSP) for 11 NWFPs as a marketing strategy on the top priority to boost up the sector. Selected modules of livelihood generate enough employment opportunities varying from 300 to 800 human days/ha at the production level. The lac sector also supports more than 150 resin-based labour-intensive industries and more than 1000 small-scale units/outlets across the country. India is leading in supplying the NWFP-based raw material for food, paint, varnish, cosmetic and pharmaceutical industries worldwide. The most common host trees for lac cultivation are *Butea monosperma* (*Palas*), *Zizyphus mauritiana* (*Ber*), and *Schleichera oleosa* (*Kusum*), besides several trees of regional importance (Roonwal *et al.*, 1958; Roonwal and Singh, 1958; Varshney and Teotia, 1967; Sharma *et al*., 1997, Pal *et al*., 2012). In addition, Flemingia semialata is popularizing for lac cultivation and rural youths are interested in lac cultivation on this bushy plant as it supports both *Kusmi* and *Rangeeni* lac cultivation like the *Ber* plant (Yogi *et al*., 2014). Data published by the Forest Survey of India shows the great scope and potential for growth in the NRG sector. The agenda for food security has been addressed for consumers, and high-value low, volume crops like lac, pine resins and gums may be a key component for the livelihood security of the small holders.

Current lac production estimates revealed that less than 10% lac host trees are utilized for lac cultivation. The government, lac-based industries, lac traders, entrepreneurs and exporters require the estimation of lac production. The cultivation of lac on a large number of hosts of different kinds, its collection by numerous small growers, variations in the yield depending on the type and size of the host, cultivation practices and climatic conditions are the major factors influencing the estimation of lac production. Production estimates of this commodity would help plan overseas as well as domestic trade regulations, price fixation and reliability in the supply of lac-based products.

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

Table 2. Lac production in India during 2019-20 (in tons)*

Name of states / Districts	Name of lac crop/strain@						Total (% share)
	Baisakhi	*Katki*	***Rangeeni***	*Jethwi*	*Aghani*	***Kusmi***	
Jharkhand	554	282	836	4947	4560	9507	10343 (54.60)
Chhattisgarh	703	512	1215	741	1522	2263	3478 (18.37)
Madhya Pradesh	1539	814	2353	50	65	115	2468 (13.03)
West Bengal	112	640	752	59	245	304	1056 (5.57)
Maharashtra	380	445	825	15	12	27	852 (4.50)
Odisha	13	10	23	155	495	650	673 (3.55)
Gujarat	4	1	5	15	7	22	27 (0.14)
Assam	5	10	15	0	0	0	15 (0.08)
Uttar Pradesh	10	2	12	0	0	0	12 (0.06)
Andhra Pradesh	5	1	6	1	5	6	12 (0.06)
Meghalaya	6	2	8	0	0	0	8 (0.04)
Total	3331 (17.58)	2719 (14.36)	6050 (31.94)	5983 (31.58)	6911 (36.48)	12894 (68.06)	18944 (100.00)

*@**Baisakhi:** - Summer season crop of Rangeeni; **Jethwi:** - Summer season crop of Kusmi; **Katki:** - Rainy season crop of Rangeeni; **Aghani:** - Winter season crop of Kusmi; $ Andhra Pradesh including Telangana;* See Annexure I for details.*

Based on a survey in the local weekly markets of different lac-producing districts, the estimated national production of sticklac during 2019-20 was approximately 18,944 tons comprising *Rangeeni* (6050 tons) and *Kusmi* (12894 tons) sticklac. Among the lac-growing states, Jharkhand state ranks first (54.60%), followed by Chhattisgarh (18.37%), Madhya Pradesh (13.03%), West Bengal (5.57%), Maharashtra (4.50%) and Odisha (3.55%). These six states contribute more than 99 % of the total lac production in India (Figure 1).

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www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

Table 3. Top ten lac producing districts in the country

District (States)	2018-19	Rank	2019-20	Rank
Ranchi (Jharkhand)	3170	1	3205	1
Simdega (Jharkhand)	2330	2	2210	2
Khunti (Jharkhand)	1470	3	1695	3
Gumla (Jharkhand)	1430	4	1512	4
Korba (Chhattisgarh)	885	5	1015	5
Kanker (Chhattisgarh)	855	6	775	9
West Singhbhum (Jharkhand)	845	7	935	6
Seoni (Madhya Pradesh)	820	8	929	7
Balaghat (Madhya Pradesh)	697	9	909	8
Gondia (Maharashtra)	570	10	602	10

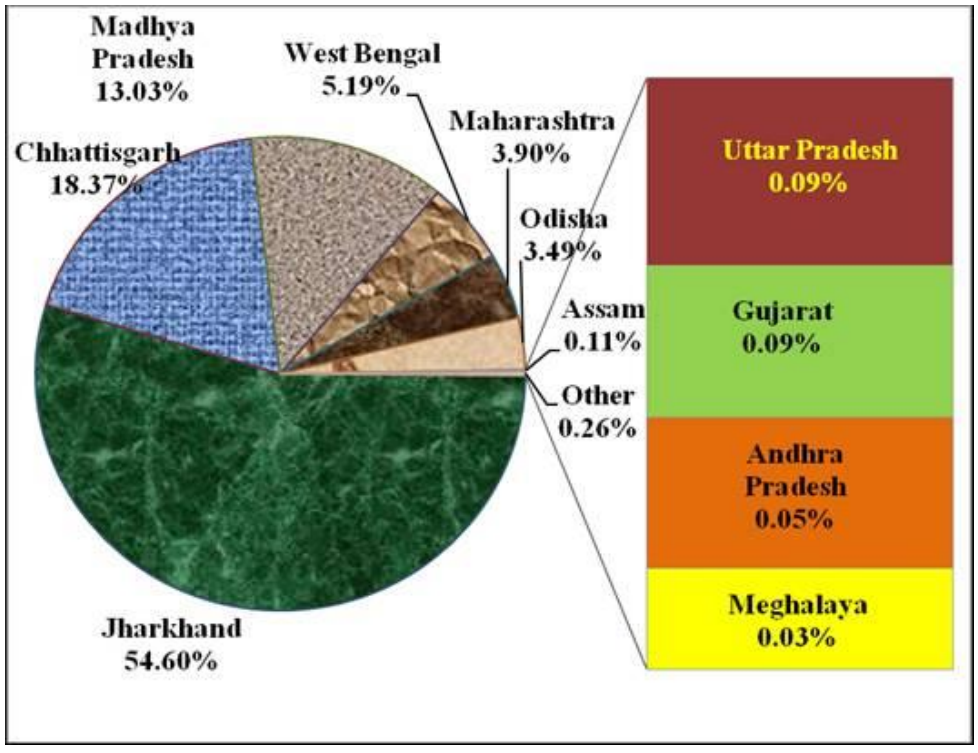

Figure 1. State-wise share in lac production during 2019-20

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ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

Compared to the average production from 2010-11 to 2019-20, the current year (2019-20) of the Rangeeni crop has declined by 9.24% while the production of *Kusmi* crop enhanced by 23.11%, respectively. The increase in production was comprised of 13.64 % and 32.68 % for the *jethwi* and *aghani* crops, respectively. However, a decrease of 13.14% and 3.96% was observed in case of *baisakhi* and *katki* crops, respectively. Overall, the total lac production for 2019-20 has increased by about 3.28 % compared to the average production. The Lac production scenario in India during 2019-20 is presented in Table 2, and the country's top ten lac-producing districts are enlisted in Table 3. Lac production in India during the previous five years is depicted in Figure 2.

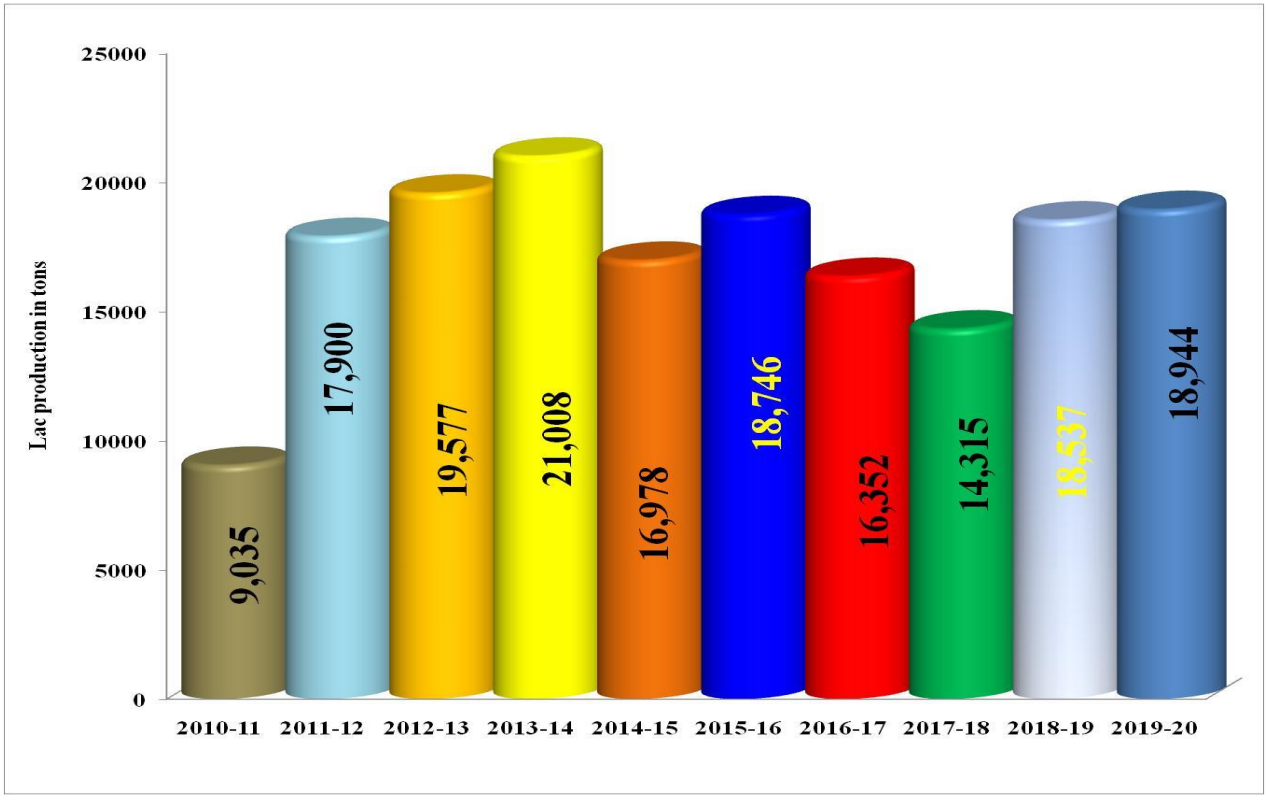

Figure 2. Lac production in India during the previous ten years

The overall lac production during 2019-20 has been estimated as 18,944 tons, which is higher than the country's previous year's production (18,537 tons). It is interesting to mention that the production level of lac is sustained at 14,315 tons during 2017-18, which is about 58 % higher compared to the lowest level of 9,035 tons during 2010-11. Although, it is about 11.53% lower than the highest level of 21,008 tons in 2013-14.

CONCLUSIONS

Raw lac is the source of three valuable products, i.e., resin, dye and wax. Lac cultivation is an important source of income for the livelihood of the forest and sub-forest dwellers of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, Odisha and parts of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region. Lac production is a highly labour-intensive process and employs both men and women dwelling in forest and sub-forest areas of these states. Being a highly remunerative crop with high economic returns to the farmers and foreign exchange of the country with recent policy interventions by the government there is abundant opportunity for entrepreneurs as well as farmers to operate the lac production and have the livelihood security.

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Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

FOOD PROCESSING IN INDIA: POLICIES, CHALLENGES AND STRATEGIES

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ABSTRACT

The food processing industry is of mammoth significance for India's development. The government's initiatives to make India Global Food Factory and Global Food Market bring immense opportunities for the food processing sector. Demand for processed food items is set to increase in India in the coming years, providing opportunities for greater value addition, lower wastage and alternative employment opportunities. Increasing the level of perishable processing products will help reduce the level of wastage, generating employment and fetching remunerative prices for farmers. This paper attempts to give information about the government initiatives to promote the industry, the challenges and suitable strategies to overcome.

INTRODUCTION

The Indian food industry is poised for huge growth, increasing its contribution to the world food trade yearly. In India, the food sector has emerged as a high-growth and high-profit sector due to its immense potential for value addition, particularly within the food processing industry. India is the second largest producer of food in the world after China. It has the potential to become a food basket for the world, considering the scope and increasing demand for food processing. The Indian food and grocery market is the world's sixth largest, with retail contributing 70% of the sales. It accounts for 32% of the country's total food market, one of the

largest industries in India and is ranked fifth in production, consumption, export and expected growth (NABARD, 2018). Food processing is a link between the agriculture and manufacturing sectors. Therefore, it helps ensure safe and healthy food at affordable prices across the population. The food processing industry in India comprises different sub-sectors, such as food grain processing, fruit and vegetable products, milk and milk products, meat and poultry products, etc. A well-developed food processing sector with a higher level of processing helps reduce wastage, improves value addition, promotes crop diversification, ensures better return to the farmers, promotes employment, and increases export earnings. This sector is also capable of addressing critical issues of food security, and food inflation and providing wholesome, nutritious food to the masses (Dhanya *et al.*, 2020)

CONTRIBUTION OF THE FOOD PROCESSING SECTOR TO GDP

Over the years, agricultural production in India has consistently recorded higher output. India ranks third in cereals, first in pulses, second in the vegetable primary, second in fruit primary, first in milk, and third in eggs primary, etc., in World Agriculture in 2018. An abundant supply of raw materials, increased demand for food products, and incentives offered by the government have positively impacted the food processing sector. During the last five years ending 2019-20, the food processing sector has been growing at an Average Annual Growth Rate (AAGR) of around 11.18 per cent as compared to around 4.19 per cent in Agriculture (at 2011-12 prices). The food processing sector has also emerged as an important segment of the Indian economy in terms of its contribution to GDP, employment and investment. The sector constituted as much as 9.87 per cent and 11.38 per cent of gross value added in the manufacturing and agriculture sector, respectively, in 2019-20 (at 2011-12 prices) (Annual Report, 2022).

1. GOVERNMENT POLICIES TO PROMOTE FOOD PROCESSING IN INDIA

1.1. FOREIGN DIRECT INVESTMENT (FDI)

- Hundred per cent (100%) FDI is permitted under the automatic route in food processing industries
- Hundred per cent (100%) FDI is allowed through the Government Approval route for trading (including e-commerce) in respect of food products manufactured in India
- Hundred per cent (100%) FDI is allowed for companies undertaking Single Brand Retail Trading in India (49% under Automatic route and approval route for beyond 49%)

- Up to 51%, FDI is permitted under the approval route for Multi Brand Retail Trading with the condition that the minimum amount to be brought-in as FDI would be USD 100 million and 50% of this amount to be invested in back-end infrastructure.

1.2. NATIONAL FOOD PROCESSING POLICY

The policy's objective is to reduce wastage, increase value addition, and ensure better farmers' prices while ensuring availability and quality produce to consumers. The significant highlights of the policy are given below:

- The single window clearance system
- Promote fruit processing clusters
- Strengthen agriculture marketing infrastructure
- Facilitation of land allotment
- Promote mage food parks/food parks
- Support the development of logistic infrastructure
- Compliance with food safety regulatory requirements
- Support to business units having established backward integration

1.3. ROLE OF MEGA FOOD PARK AND ITS LINKAGES WITH FPOS IN THE PROMOTION OF THE FOOD PROCESSING SECTOR

The scheme of the mega food park aims to create a modern infrastructure of food processing and to provide a mechanism to bring together farmers, processors and retailers and link agriculture production to the market so as to ensure maximizing value addition, minimizing wastage, increasing farmers' income and creating employment opportunity especially rural areas. The government has operationalized 42 mega food parks in the country.

1.4. OTHER ENABLING SUPPORT FOR INVESTMENT

- The government of India facilitates investment in the food processing sector through a number of incentives announced from time to time. The major incentives are as under Income tax relief under sections 80 IB, 35 AD and 10 AA of Income Tax Act,1961.
- GST for food processing machinery ranges from 5% (machines for cleaning, sorting or grading, seed, grain or dried leguminous vegetables; machinery used in milling industry or for the working of cereals or dried leguminous vegetables other than farm type machinery and parts thereof), 12% (dairy machinery, milking machines), 18% (machinery for the industrial preparation or manufacture of food or drink, other than

machinery for the extraction or preparation of animal or fixed vegetable fats or oils) to 28% (freezers and refrigerating equipment, etc.)

2. GOVERNMENT OF INDIA (GOI) SCHEMES AND INITIATIVES

There are a number of central sectors and centrally sponsored schemes operating for the promotion of cold chain, agri-marketing infrastructure and food processing industries. The details are discussed in this section:

2.1. CENTRAL SECTOR SCHEMES

2.1.1. PRADHAN MANTRI KISAN SAMPADA YOJANA

The Government of India (GoI) has approved a new Central Sector scheme – PM Kisan SAMPADA (Scheme for Agro Marine Processing and Development of Agro-Processing Clusters) with an outlay of 6000 crore rupees for the period 2016-20 co-terminus with the 14th Finance Commission cycle. The Ministry of Food Processing Industries, GoI New Delhi implemented the scheme. SAMPADA is a comprehensive package that creates modern infrastructure from farm gates to retail outlets.

The scheme consists of the following sub-schemes:

i. Mega Food Parks
ii. Integrated cold chain and preservation infrastructure
iii. Creation/expansion of food processing and preservation capacities
iv. Infrastructure for agro-processing clusters
v. Creation of backward and forward linkages
vi. Food safety and quality assurance infrastructure
vii. Human resources and institutions
viii. Operation Greens

2.1.2. MISSION FOR INTEGRATED DEVELOPMENT OF HORTICULTURE (MIDH)

Ministry of Agriculture launched MIDH, GoI by subsuming various existing schemes such as National Horticulture Mission (NHM), Horticulture Mission for North East & Himalayan States (HMNEH), National Bamboo Mission (NBM), National Horticulture Board (NHB), Coconut Development Board (CDB) & Central Institute for Horticulture (CIH). The subsidy for post-harvest management and cold chain projects implemented through NHM and NHB are also part of the MIDH.

2.1.3. PRODUCTION LINKED INCENTIVE SCHEME FOR FOOD PROCESSING INDUSTRY

Union Cabinet, in its meeting on 31.03.2021, approved the Central Sector Scheme- "Production Linked Incentive Scheme for Food Processing Industry (PLISFPI)" to support the creation of global food manufacturing champions and support Indian brands of food products in the international markets. The PLISFPI has been formulated based on the Production Linked incentive scheme of NITI Aayog under "Aatma Nirbhar Bharat Abhiyaan for Enhancing India's Manufacturing Capabilities and Enhancing Exports". The scheme will be implemented for a six-year period from 2021-22 to 2026-27. The Scheme Objectives are to extend financial support to food manufacturing entities, with stipulated minimum sales and willing to make a committed investment for the expansion of food processing capacity and incur expenditure in branding & marketing of food products abroad to facilitate the emergence of strong Indian brands.

2.2. CENTRALLY SPONSORED SCHEMES

2.2.1. NATIONAL FOOD SECURITY MISSION (NFSM)

The Government of India enacted Food Security Act with a right to every targeted beneficiary belonging to the eligible targeted public distribution system to receive 5 kilograms of food grains at a subsidized price. The scheme is implemented through State Government and requires investment in post- harvest management, especially warehousing and transport logistics.

2.2.2. PM FORMALIZATION OF MICRO FOOD PROCESSING ENTERPRISES (PMFME) SCHEME

As part of Aatmanirbhar Bharat Abhiyan, the Ministry of Food Processing Industries (MoFPI) has launched an all India centrally sponsored "PM Formalization of Micro food processing Enterprises (PMFME) Scheme" for providing financial, technical and business support for the upgradation of existing micro food processing enterprises. It is to be implemented for five years, from 2020-21 to 2024-25, with an outlay of Rs. 10,000 cr. Two lakh micro food processing units will directly assist with credit-linked subsidies.

The objectives of the scheme are as under:

- Increased access to credit by existing Micro Food Processing entrepreneurs, FPOs, Self Help Groups and Co-operatives;
- Integration with an organized supply chain by strengthening branding & marketing;

- Support for the transition of existing 2,00,000 enterprises into a formal framework;
- Increased access to common services like common processing facilities, laboratories, storage, packaging, marketing and incubation services;
- Strengthening of institutions, research and training in the food processing sector; and
- Increased access for the enterprises to professional and technical support.

2.3. OTHER INITIATIVES

2.3.1. START-UP INDIA

The programme was announced in January 2016 with an action plan for promoting bank financing for Start-Up ventures to boost entrepreneurship and encourage start-ups with job creation. Start-up is an entity incorporated or registered in India not prior to seven years (for biotechnology not prior to ten years) with an annual turnover not exceeding 25 crore rupees in any preceding financial year working towards innovation, development or improvement of products, processes or services or if it is a scalable business model with a high potential of employment generation or wealth creation. A Start-up India online hub was also launched in June 2017.

2.3.2. STAND-UP INDIA (SUI)

The Government of India launched the Stand-up India scheme in April 2016 to support at least one SC/ST and one women entrepreneur per bank branch to set up greenfield enterprises in manufacturing, services or the trading sector and become job creators. Over 16,000 new enterprises have come up through this scheme in activities as diverse as food processing, garments, diagnostic centres, etc. The scheme offers a huge opportunity for investors in the food processing sector. Small Industries Development Bank of India (SIDBI) operates and maintains the Stand-up India portal and acts as connect centre along with NABARD.

2.3.3. SKILL INDIA

Skill development in the food processing industry is a major challenge today. There is a dearth of skilled workforce. As per a study conducted by National Skill Development Corporation (NSDC) on human resources and skill requirements in the food processing sector, the annual human resource requirement in the food industry is estimated at 5.3 lakh people, including one lakh, in the organized sector. Skill India programme was launched in July 2015 to train a minimum of 300 million people in India in different sectors by 2022. The following are some of the flagship programmes of the Government of India for promoting skill development in the country.

2.3.3.1. PRIME MINISTER KAUSHAL VIKAS YOJANA (PMKVY)

GoI launched the scheme in July 2015 to skill one crore youth of the country with an outlay of 12000 crores. It is being implemented by the National Skill Development Corporation (NSDC). The centre is implementing the PMKVY (2016-2020) along with the states, which have three training formats. Short-Term Training (STT), Recognition of Prior Learning (RPL) and Special projects. Pradhan Mantri Kaushal Kendra (PMKK) plays a crucial role in imparting vocational training to the youth. Under PMKVY, training is imparted for pickle-making technicians, traditional snacks and savoury makers, baking technicians, mixing technicians, plant biscuit production specialists, etc.

2.3.3.2. UDAAN

It is the Special Industry Initiative (SII) for Jammu & Kashmir to train 40000 unemployed youth in J&K over six years. It is funded by the Ministry of Home Affairs and implemented by the NSDC of India. Increasing investments in the sector have led to higher demand for more qualified people.

2.3.4. MAKE IN INDIA

The programme was launched by GoI in September 2014. Under this initiative, 25 thrust sectors, including manufacturing and relevant services sectors, have been identified. The major objective of the scheme is to improve the competitiveness of the private and public sector firms operating in the country, facilitating their integration into the global value chains and enabling them to compete better in the global markets.

3. CHALLENGES FOR THE GROWTH OF THE FOOD PROCESSING SECTOR IN THE COUNTRY

- Lack of a comprehensive national food processing policy leads to inconsistent central and state policies.
- Delays in land acquisition due to requirement of conversion of land use (non-agricultural use permission).
- Inadequate infrastructure for storage, sorting, grading and post-harvest management, road connectivity, sea ports, airports, information and marketing linkage, electricity and cold chain are the Indian food processing industry's biggest constraints.

- Lengthy procedures for Government clearance - The clearances from Government apartments like Municipal/ Town Planning Authorities, Pollution Control Board, State Electricity Department, Boiler Inspector, etc., usually delay project implementation.
- The dominance of unorganized sector (42%) & small scale (28%) in the food industry operating at low scale and high cost of production.
- Organized production of raw materials for processing leads to low recovery rate, high cost of raw materials and low-quality products.
- Inadequate facilities for mentoring of Start-Ups and pilot testing of technologies and innovations. There is also a lack of applied research on processes and technology.
- The high cost of manufacturing and packaging makes the products' luxury items unaffordable to the common population.
- Fluctuation of raw material prices leading to viability issues in food industries. The sudden rise in the prices of raw materials have resulted in the past temporary or complete shutdown of food factories.
- Inadequate flow of credit, especially for working capital requirements. The assessment of the working capital cycle followed by banks does not hold good due to the seasonal availability of raw materials.
- Non-availability of skilled man power for food processing is a big challenge. Industrial training institutions providing skill-based training/diploma courses are limited.
- Poor adoption of quality standards by the food industry led to a lowering of the brand value of the Indian Food Industry.
- Lack of market intelligence and brand building in Indian Food Processing Industries (Makda, 2019).

4. STRATEGIES TO PROMOTE THE FOOD PROCESSING SECTOR IN THE COUNTRY

- A National Food Processing Policy may be formulated to follow a uniform approach for the food processing sector on a Pan-India basis.
- Relax non-agricultural land use permit for the food industry procuring raw materials directly from the farmers and to Farmer Producer Organizations
- The Single Window approach for Government clearances may need to be in place in all the States.

- Exclusive Food Technology Skilling Mission for bridging the skill gap in food in view of the emerging food safety systems and food standards.
- The Model Contract Farming Facilitation Act 2017, under consideration of the government, may need to be expedited.
- Constituting a task force to study the working capital requirement and adequacy of working capital finance to the food industry, especially considering the recent initiatives of the GoI such as Make in India, etc.
- Providing affordable credit to the food processing Industry to promote the creation of investments in the sector.
- Enlarging the scope of the credit guarantee fund/creating of a risk fund will help mitigate stress on the banking industry on financing the sector, which is mostly seasonal and capital and labour intensive.
- Infrastructure for setting up food research and testing facilities and traceability may be promoted in a big way to provide safe food in the domestic market and also remain competitive in the world market.
- Creation of a National Brand Equity Fund for Food Industry with a contribution from Industry Associations, GoI, etc. to India brands internationally.
- Make in India to focus on manufacturing plant and machinery and packaging materials locally to reduce cost of production.

CONCLUSION

Food processing Industry in India has seen remarkable growth and changes over the past few years driven by changing trends in market, consumer behaviour and Government initiatives. India's food processing industry is dominated by a highly fragmented, unorganized sector with small operations. About 42% of the output comes from the unorganized sector, 25% from the organized sector and the rest from small-scale players. The processing level in non-perishable products such as cereals and pulses are more than 90%. However, only 7 per cent of the total Indian perishable produce is processed, which is significantly lower compared to countries. A fragmented and lengthy supply chain, inadequate infrastructure, skill gap in human resources, low adherence to quality standards, capital-intensive nature of the industry and taxation issues are the major challenges this sector faces. Addressing these challenges will take this industry to par with its global counterpart. The Government of India's focus towards the food processing industry is the key to double farmer's income.

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Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022

PRECISION FARMING: AN EYE OPENER FOR FUTURE FARMS

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ABSTRACT

Precision farming is about doing the right thing, at the right place, at the right way, at the right time. Managing crop production inputs such as water, seed, fertilizer, etc. increase yield, quality, and profit, reduce waste, and becomes eco-friendly. Precision farming aims to match agricultural inputs and practices per crop and agro-climatic conditions to improve the accuracy of their applications. Precision farming can be an eye-opener to modern-day farming not only in developing countries like India. In an era of climate change precise agriculture will help reduce resources used, which will help reduce global warming.

INTRODUCTION

We are all accustomed to "farming, " the backbone of our Indian economy. About 60 – 70 % of Indian households are financially dependent on agricultural activities. India dominates the world agriculturally. It is the world's largest milk producer, pulses, spices, etc. It is the second-largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep & goat meat, fruit, vegetables, and tea. Still, the condition of the farming class has not improved for decades. The question of the hour is WHY? Whenever we imagine a farmer in India, we always imagine a poor man with a 'gamcha' as his head turban, mud-cladded feet, hands, no smile on his face, and looking economically backward. After all these good yields and production still, we are somehow failing. Why is it so? What are the shortcomings? Where are we lacking? What improvements need to be done? Such type of questions lingers in our mind most often.

The reasons why I feel that Indian farmers are still lagging in the farming sector is maybe due to a few reasons. Gambling during monsoons is one of the big reasons for crop loss and property loss in the northeastern part of the country. Uncertain rains causing sudden floods

destroy a huge number of crops and livestock. The presence of the middleman spoils most of the chances of profit for the farmer. The lack of transport facilities makes it very difficult for the farmers in remote regions to make their products reach the market. As lack of good road conditions also hampers a lot. They are ready to sell the produce at a much lower price as they do not have a proper mode of transportation. Improper implementation of schemes: There are too many schemes to help the farmer, but not all are implemented properly. This also deprives the farmer of the basic profit they may get benefitted. Then they use fertilizers which also degrades fertility to another level. Frequent power cuts hamper the irrigation facilities and slow down the pace of the work on the fields. Unaware farmer: The less educated farmer is unaware of all the facilities, policies, and provisions meant for them. Lack of modern equipment-Affordability remains a problem. Moreover, this, inturn, contributes to the vicious cycle of poverty.

So, is there any solution to all of these problems? Well, maybe yes!

In the wake of climate change leading to unprecedented rains in the country, depletion of natural resources, and an imminent food crisis, India must move beyond conventional and aggressive farming and towards precision farming. Precision farming, although at a budding stage in India, can help the country become the top agricultural producer globally if every state comes forward.

WHAT IS THIS PRECISION FARMING?

Precision farming can be defined as a farm management system that harnesses information and communications technology (ICT), the Internet of Things (IoT), artificial intelligence (AI), data analytics, and other advanced technologies to minimize production costs and maximize farm productivity, profitability, and sustainability. Precision farming focuses on deploying the right inputs at the right time and the right place in the right manner. Furthermore, it undertakes a comprehensive approach to maintaining field and soil wellbeing in a way that elevates the Q2 aspect of agriculture, i.e., quality and quantity while minimizing environmental harm.

The concept of precision farming is strictly based on the Global Positioning System (GPS), which was initially developed by US (United States of America) defence scientists for the exclusive use of the US Defense Department. The unique characteristic of GPS is precision in time and space. Precision farming, as the name implies, refers to the application of precise and correct amounts of inputs, like water, fertilizers, pesticides, etc., at the correct time to the

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ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

crop to increase its productivity and maximize its yields. The use of inputs (i.e. chemical fertilizers and pesticides) is based on the right quantity, time, and place. Precision Farming is a combination of an application of different technologies. All these combinations are mutually interrelated and responsible for developments. The components primarily include Global Positioning System (GPS), Geographic Information System (GIS), Grid Sampling, Variable Rate Technology (VRT), Yield Maps, Remote Sensors, Proximate Sensors, Computer Hardware and Software, Precision irrigation systems.

A file pic of need-based precision nutrient application

SCOPE AND ADOPTION OF PRECISION FARMING IN INDIA

Precision farming for small farms can use small farm machinery and robots which will not compact the soil and may also run-on renewable fuels like bio-oil, compressed biogas, and electricity produced on farms by agricultural residues. For small farms, precision farming may include sub-surface drip irrigation for precise water and fertilizer application, weed removal, harvesting, and other cultural operations. Similarly, drones have also been introduced to map farms, identify diseases, and so on. Most robotic machines and drones are compact and thus suitable for small farms. India's small farms, therefore, are ideal for the large-scale application of precision farming.

The most important component in moving to precision farming will be creating a huge resource of engineers, scientists, and agriculturists to develop various technology components. Without an excellent workforce, even good research and development of precision farming will not succeed. Unfortunately, most good students want to get into engineering and medical streams, and ignorantly, agriculture becomes an afterthought. We should encourage our students to pursue agriculture, as it is our backbone, powerhouse, and roots. It is high time that

Industries and farmers work together, interact and collaborate to develop intelligent systems for precision farming. This will attract students to pursue agriculture, which will help develop our nation's future farms. High-tech precision farming therefore can help in bringing the next green revolution in India and can produce tremendous rural wealth in a sustainable and environmentally sound way by minimizing water loss, reduction of chemical fertilizers, reduction in the use of electricity which is climate-friendly this will help India reach its goal of Net zero 2070 emissions target. Thus, precision farming is a boon to our modern-day agriculture and will help build our future farms in a greener way. As responsible fellow beings, we need to care for our planet and help stop the climate change phenomena through clean and green agriculture.

ADVANTAGES

Agronomical Perspective	Use agronomical practices by looking at the specific requirements of a crop
Technical Perspective	Allows efficient time management
Environmental perspective	Eco-friendly practices in crop
Economical perspective	Increases crop yield and quality and reduces production costs by efficiently using farm inputs, labor, water, etc.

CONCLUSION

Precision farming is about doing the right thing, in the right place, in the right way, at the right time. Managing crop production inputs such as water, seed, fertilizer, etc. increase yield, quality, and profit, reduce waste, and becomes eco-friendly. Precision farming aims to match agricultural inputs and practices per crop and agro-climatic conditions to improve the accuracy of their applications. Precision farming can be considered an eye-opener to modern-day farming not only in developed countries but also in developing countries like India. In an era of climate change and global warming, precise agriculture will help reduce resources used, which will help reduce global warming.

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Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

MONKEY JACK: A BEST ALTERNATIVE TO FODDER CROPS

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ABSTRACT

Monkey Jack (Artocarpus lakoocha Roxb.) is an important tropical tree species commonly observed among South Asian nations. It is a wild species of Jackfruit which is a multipurpose tree that provides fruit, fuel, timber, medicine, dye, and thick shade. The tree's green leaves are used as fodder for milch animals in different parts of India as it has a rich source of crude protein and other minerals. Monkey jack (Artocarpus lakoocha Roxb.) provides multiple benefits and services to the ecosystem.

INTRODUCTION

Agroforestry systems can be advantageous over conventional agricultural and forest production methods. They can offer increased productivity, social, economic and environmental benefits, and greater diversity in the ecological goods and services. Multipurpose trees are also a part of the agroforestry system. In addition to providing fodder, fuel, wood, and other products, trees in agroforestry systems promote soil and water conservation, enhance soil fertility, and act as windbreaks for nearby crops. Multipurpose tree species that are purposefully grown to provide two or more products and service functions like shelter, shade, and land sustainability of the land-use system. Fodder trees are essential to feed sources for livestock in a wide range of farming systems worldwide. Low quality and quantity of feeds significantly limit livestock productivity among smallholder farmers. In many countries, farmers have fed tree foliage to their livestock for centuries, using wild browse or trees that grow naturally on their farms. New agroforestry systems for feeding livestock have emerged over the last three

Agri JOURNAL WORLD
ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

decades, involving planting mostly exotic species grown most frequently in hedges along field boundaries or the contours to limit soil erosion.

Pic 1. The ripened fruit of Monkey jack (*Artocarpus lakoocha*)

It is a tropical tree species which is widely distributed among South Asian countries like India, Sri Lanka, Bangladesh, Thailand, Cambodia, Malaysia, Indonesia and Singapore. It is generally

Pic 2. Unripe fruits for pickle making

found in Sub-Himalayan humid regions of India and grows up to an altitude of 1200 meter above MSL (Dwivedi *et al*., 2011). The *A. lakoocha* has medium to large growth habits with both deciduous and evergreen natures. The deciduous period is very short in Eastern India, which generally commences in February and ends in early March, where it has been reported to be absent in Western Ghats (Krishnamurthy and Sarala., 2013). It can grow up to 15 m in

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height and makes a handsome ornamental tree. The leaves are oblong, acute, alternate, 10-25 cm with long, glossy green on the upper side, whereas old leaves are rough.

Pic.3 Fully grown tree of Monkey Jack

SCOPE OF MONKEY JACK AS A GREEN FODDER

Monkey Jack (*Artocarpus lakoocha*) is a wild species of Jackfruit which is a multipurpose tree that provides fruit, fodder, fuel, timber, medicine, dye, and thick shade. The large green leaves are excellent fodder which contains 16 % crude protein (Kharel *et al*., 2000). A tree can produce 60 to 200 kg of leaves per year (Orwa *et al*., 2009). It is considered one of the best forages for milch animals due to its palatability and nourishing values in Nepal and

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fodder for goats in Jharkhand (Dhungana *et al*., 2012). A single fruit weighing between 250 g and 300 g contains 10-30 seeds which are irregular in shape and vary in size. Fresh fruits and seeds have high nutritional and medicinal value. The unripe fruit and male flower spike are used as a vegetable, to make pickles, sauces and chutneys. The fruits are sweet-sour in taste. The edible pulp is reported to have hepatoprotective properties due to the presence of antioxidants (Gautam and Patel., 2014) and is considered a liver tonic (Hari *et al*., 2014). It is used in anti-inflammatory therapy and as an anti-ageing agent (Mongolsuk *et al*., 1957). The powdered bark is used as a paste to cure skin ailments like boils, pimples, and sores. *A. Lakoocha* is reported to be widely used in the ethno-medicinal formulations by the tribal people of Jharkhand (Pandey and Bhatnagar., 2009). Leaves of *A. lakoocha* containing moisture (61.0%), total ash (8.0%), crude protein (28.6%), crude fat (1.52%), crude fibres (26.3%) and

Pic.4 Leaves of Monkey Jack (A rich crude protein source) used as fodder

carbohydrates (0.84%) respectively. Due to the high protein content and palatability, it will help eradicate fodder deficiency in dry months. It contains a higher amount of crude protein, which might be helpful to enhance milk production in milch animals even though it can help maintain body weight and reproduction. Considering this tree's importance, it will be helpful to provide ample amounts of essential nutrients to live stock in each season.

LIMITATION

A few drawbacks associated with *A. lakoocha* include:

1. The tree population of *A. lakoocha* is gradually decreasing due to its extensive exploitation for food, fodder, timber and other uses.
2. Once extracted from the fruit, seeds quickly lose viability within a week, or sometimes even in a few days.
3. Vegetative propagation methods, such as rooting of hardwood or softwood stem cuttings, have not been successful (Napier and Robbins, 1989). Budding has been reported to be successful, with only a single report in Western Himalaya (Sharma *et al*., 2005).

CONCLUSION

Monkey Jack (*Artocarpus lakoocha)* can play a crucial role as a potential tree species for nutrition, poverty alleviation, and environmental, agricultural and forest ecosystem diversification and is capable of creating new market opportunities for the livelihood security of rural people if the drawbacks associated with it can be addressed through proper scientific research and development works on it.

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ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

SCP-SINGLE CELL PROTEIN: AN EASILY ACCESSIBLE FOOD SOURCE

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ABSTRACT

Single-cell protein (SCP) is defined as dried microbial cells or total protein from pure or mixed cultures of algae, yeasts, fungi, or bacteria and is used as a substitute for protein-rich food in human and animal feeds. Due to the increase in the global population, the high demand for protein-rich foods has increased the global challenge to meet novel approaches for alternative food sources. Furthermore, SCP strains eradicate pathogenic microorganisms from the gut. In addition, SCP has various benefits over animal and plant proteins as microbial growth is climate independent, needs a short generation time, does not require a large expanse of land, can be grown on waste materials, and allows easy transformation.

INTRODUCTION

The rapid increase in the world population has increased the demand for protein-rich food items at a rapid pace in underdeveloped and developing countries. The use of yeast in bread and beverage production started in 2500BC. During World War II, when there were limited conventional protein and vitamin sources in the diet, Germany started to use yeast and mold in their food. After the war, other countries started large-scale production of yeast food. Single-cell proteins (SCP) is not pure protein and refers to the total protein extracted from pure microbial cell culture (algae, bacteria, filamentous fungi, yeast), which can be used as a food supplement to humans or animals. In addition, it may be a useful source of vitamins, minerals, and carbohydrates. SCP production began in the 1960s. The term SCP was first coined at the Massachusetts Institute of Technology. Pruteen was the first commercial SCP and was produced from *Methylophilus methylotrophs* used as an animal feed additive.

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ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

ADVANTAGES OF SINGLE-CELL PROTEIN

- The primary advantage of SCP production is that microbial culture can create a high amount of protein with low fat just by providing appropriate conditions. As a result, the quantity and quality of protein generated from these bacteria are superior to that of other animals and plants.
- No animal rights issues.
- Microbes are easy to manipulate genetically.
- They can grow various cheap waste products from agriculture and industry. This also helps to reduce environmental pollution.
- Occupy less space than conventional crops.
- The fermentation procedures, as well as the culture conditions, are both simple. The generation of microorganisms is not affected by environmental factors.

PRODUCTION OF SINGLE-CELL PROTEIN

The basic steps involved in SCP production are

- Selection of suitable strain
- Preparation of suitable medium
- Fermentation
- Separation and downstream process

SCP Bacteria

Methylophilus Methylotrophs, Pseudomonas, Cellulomonas, and *Alcaligenes* are commonly used for SCP production. They contain more than 80 per cent of protein but are limited in sulfur-containing amino acids. The main disadvantages are high nucleic acid content and chances of endotoxin production during cultivation.

SCP Yeast

Torula yeast (*Candida utilis*) was produced in Germany during World War I and is used in soups and sausages. Yeast cells are a rich source of vitamin B. Nowadays, the pet food industry uses it as a food supplement, making the product more palatable to animals. The main advantage of yeast cells as SCP is that it is easy to harvest due to their larger size and high level of malic and lysine content. Unfortunately, it has disadvantages like lower growth rate, methionine, and protein content than bacteria.

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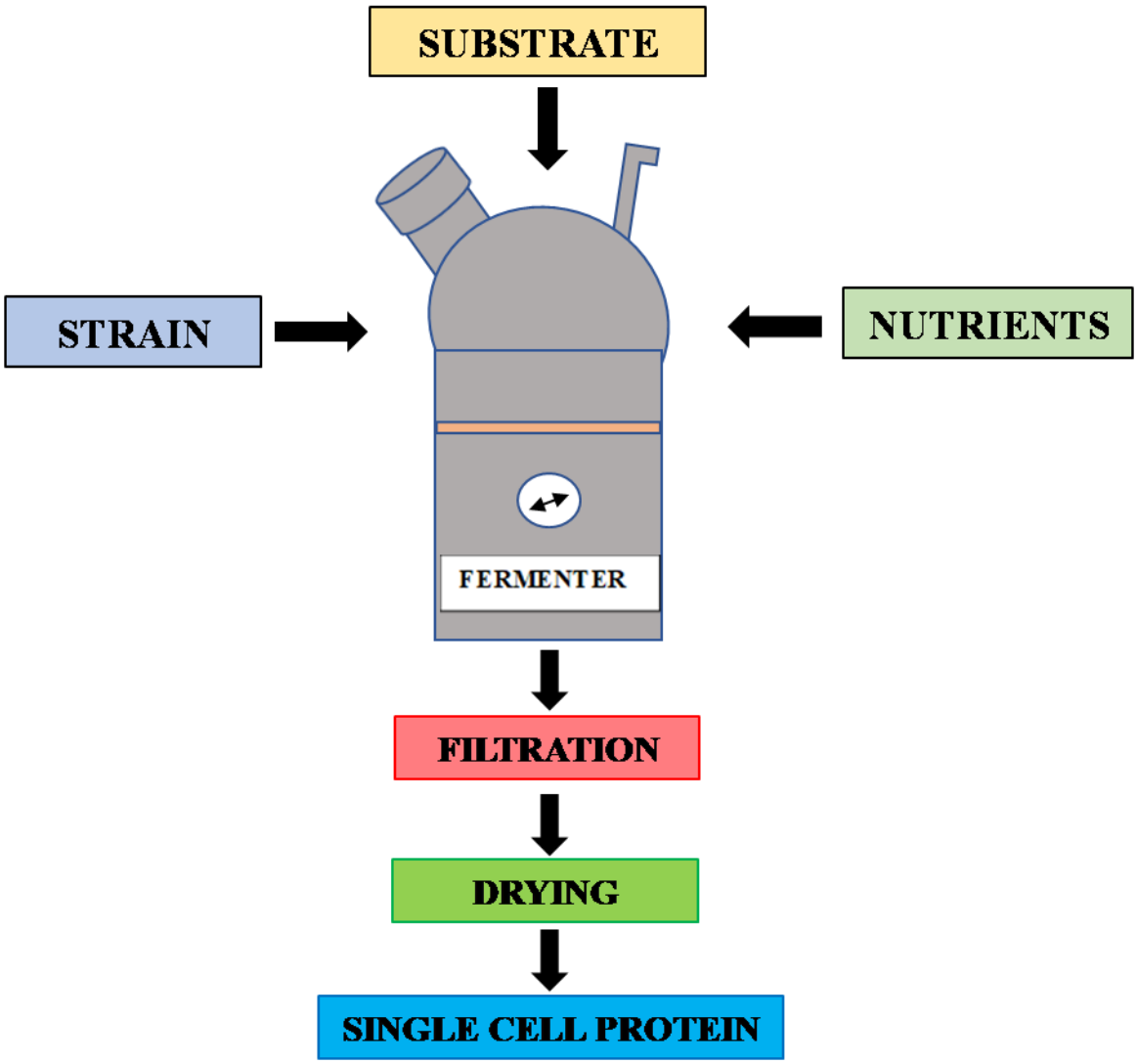
ONLINE ISSN: 2583-4339
www.journalworlds.com
VOLUME 2 ISSUE 10 OCTOBER, 2022



SCP Algae

The use of algae as food and feed has been known for centuries. Some algae like *Chlorella, Coelastrum, Soenedesmus*, and *Spirulina* have been found to be good for mass cultivation and utilization. Algae are easy to cultivate, have fast growth, and have high nutrient &protein

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VOLUME 2 ISSUE 10 OCTOBER, 2022

Table 1. Microorganisms used for SCP production using various carbon source

CARBON SUBSTRATE	MICROORGANISM
Carbon dioxide	*Spirulina* species, *Chlorella* species
Glucose	*Lactobacillus* species
Methane	*Methylomonas methanica, Methylococcus capsulatus Ralstonia sp., Brevibacillus agri, Aneurinibacillus sp.*
Liquid hydrocarbons (n-alkanes)	*Saccharomycopsis lipolytica, Candida tropicalis*
Methanol	*Methylophilus methylotrophus, Hyphomicrobium* species *Candida boidinii, Pichia angusta*
Lignocellulosic wastes (solid substrate)	*Chaetomium* species, *Agaricus bisporus, Cellulomonas*species
Whey	*Kluyveromyces marxianus, Kluyveromyces lactis Penicillium cyclopium*
Molasses	*Candida utilis, Saccharomyces cerevisiae*
Rice bran	*Aspergillus flavus, Fusarium semitectum, Aspergillus oryzae Cladosporium cladosporioides*
Inulin (a polyfructan)	*Candida* species, *Kluyveromyces species, Yarrowia lipolytica*
Cheese whey	*Kefir* sp.
Potato starch processing waste	*Bacillus licheniformis, Bacillus pumilis, Aspergillus niger Candida utilis*

contents, and are photosynthetic. However, except for *Spirulina* all others are rich in chlorophyll content, so they are not advisable for human consumption.

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ONLINE ISSN: 2583-4339
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VOLUME 2 ISSUE 10 OCTOBER, 2022

SCP Fungi

Some filamentous fungi and actinomycetes can produce proteins from different substrates. For example, *Rhizopus* and *Fusarium* were used as protein food during World War. The inoculum of *Rhizopus arrhizus* was chosen because of its nontoxic nature. The cultivation of basidiomycetes or mushroom-type fungi (*Agaricus bisporus* and *Lentinus edulus*) plays a prime role in SCP production; it is used directly as a portion of human food.

POTENTIAL SUBSTRATE FOR SCP

There is various type of nontoxic, non-exotic, renewable, cheap and non-seasonal substrates for the production of SCP. Single-cell proteins develop when microbes ferment waste materials, including wood, straw, cannery, and food-processing wastes, residues from alcohol production, hydrocarbons, or human and animal excreta. The most commonly used substrate for single-cell production substrates includes fruit, molasses, starch and vegetable waste, while unconventional substrates are natural gas, methanol, ethanol, petroleum by-products, and lignocellulosic biomass.

DISADVANTAGES OF SINGLE-CELL PROTEIN

- SPC ingestion may induce serious gastrointestinal problems because humans have a limited capacity for decomposing nucleic acid.
- High nucleic acid concentration may induce high uric acid levels in the blood.
- Regular high-level SCP induces kidney stones and gout.
- High risk of contamination, and sometimes mycotoxins are also produced.

APPLICATION OF SINGLE-CELL PROTEIN

- They are used for therapeutic and pharmaceutical purposes against lifestyle diseases.
- Application for hair and skin care products.
- Used as the best protein supplement for malnourished people and can be benefitted from a protein supplement.
- A convenient feeding source for farm animals.

CONCLUSION

SCP has a proven record as the best source of protein. At the present time, SCP production is in its infancy. Yeast and filamentous fungi show higher promise as SCP for human consumption than bacteria. The continued research should incorporate the development of recombinant strains for animal and human consumption.

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