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Agripreneurial Landscape in the Kumaon Region of Uttarakhand

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Abstract

By examining the socio-economic dynamics and constraints faced by agripreneurs, this study seeks to shed light on the transformative potential of agripreneurship in bolstering agricultural sustainability and rural livelihoods. While agricultural productivity thrives, marketing hurdles persist due to challenging terrains and inadequate infrastructure. Recent studies highlight the evolving landscape of agripreneurship globally, emphasizing sustainable, community-oriented agricultural practices. Furthermore, socio-economic, communication, and psychological attributes influence agripreneurs' decision-making and risk-taking abilities. Constraints such as inadequate marketing channels, price fluctuations, and technological limitations impede agripreneurs' endeavors. Agripreneurship, integral to agricultural development, fosters innovation, sustainability, and economic growth. Entrepreneurial ventures catalyze technological advancements, revolutionizing farming practices and enhancing productivity. Embracing entrepreneurship in agriculture not only boosts rural economies but also ensures food security and rural development.

Keywords: Agripreneurship, India, status, landscape, kumaon.

Introduction

Agriculture is the backbone of India, where the agro-based industry is considered an extended arm of agriculture. India manages 17.50 per cent of the world's population and 2.4 per cent of the world's total land. At the time of independence, more than half of the national income was contributed by agriculture, and more than 70 per cent of the total population was dependent on agriculture. Agriculture contributes 18.3 per cent to GDP, 11.9 per cent of total exports, and employs 58.40 per cent of the country's workforce. About 65 per cent of the population is directly or indirectly

related to agriculture. With the development of agro-based industries, more employment opportunities can be created both at the production and marketing stages. Even though India is the second-largest producer of food in the world, it accounts for only 1.60 per cent of the total international food trade. This indicates vast potential for agribusiness. The agricultural sector plays a vital role in global economies, contributing significantly to both the livelihoods of individuals and the overall economic development of nations.

Uttarakhand is predominantly a hilly region. Its geographical area is divided into two divisions (Kumaon and Garhwal). There are a total of 13 districts. The state covers a total area of roughly 53483 square km. The state is largely hilly (86%), and only some areas lie in plains (14%). With a 23.4 percent share in the state GDP, agriculture is the main economic sector in the state. The state is characterized by its agripreneurs excelling in agricultural production, but challenges persist in the domain of marketing. The difficult geographical terrain and inadequate infrastructure present transportation challenges, elevating costs and impeding timely market delivery**.** There is an ample amount of potential in the farming communities that they have mastered in production. Additionally, the remote location of offending communities restricts access to mainstream markets, hindering direct connections with buyers and favorable price negotiations**.** Post-harvest losses and diminished product quality result from limited modern storage and processing facilities, affecting overall marketability. The absence of developed marketing infrastructure, such as cold storage and packaging units, hampers the agribusiness's capacity to add value and access diverse markets.

Singh and Singh (2017) conducted a study highlighting the challenges in Indian agriculture, emphasizing issues related to market access, fragmented supply chains, and the need for modernization. A significant transformation has occurred globally, particularly in the realm of entrepreneurship, following the pandemic. A noticeable shift in various aspects is evident when comparing the pre-pandemic and post-pandemic eras. This change is particularly pronounced in the Indian subcontinent, which is endowed with diverse agro-climatic zones. The domain of entrepreneurial marketing in agriculture has witnessed substantial growth, extending beyond traditional agriculture and horticulture to encompass sectors such as poultry, fishery, CHC (Community Health Center) centers, seed and fertilizer licensing, as well as nursery and floriculture centers. The expanded opportunities have led to notable changes in pre-production, production, harvesting, post-harvest processes, marketing strategies, customer services, and feedback mechanisms.

Global scenario of agripreneurship

Most countries have an economy that is dependent on agriculture, either in a small or big way. From employment generation to contribution to national income, agriculture

is important. In 2010, around 25 million people were regularly engaged in agricultural work in the European Union, and 58 per cent of men were working full-time on farms. In the case of contribution towards national income, agriculture contributes more than 50 per cent in developing countries and normally a smaller percentage in developed countries. Agricultural business as a concept has grown as well. A decade ago, it was associated solely with the production of basic crops and selling them in the market. Globally, more than 66 per cent of the world's population is predicted to be urban by 2050. A serious implication of expanding urbanization will be a decline in the rural population. To ensure the sustainability of food production, rural communities, and natural resources, there is a need to slow the outmigration of rural populations by accelerating rural development.

Socio-economic, communication, and psychological characteristics of agripreneurs

Linajoy *et al.* (2008), in their study on women-led agro-processing self-groups, reported that the majority (80.00%) of the respondents had innovativeness in powder making, followed by ready-to-eat items (15.00%) and fish processing (5.00%). George *et al.* (2012) observed that more than two-thirds (68.00%) of SHG members had medium social participation, followed by high (22.00%) and low (10.00%) social participation. Naidu (2012) concluded from his study that the majority (61.67%) of respondents had medium decision-making ability, followed by high (20.00%) and low (18.33%) decision-making ability. Ram *et al.* (2013) studied the entrepreneurship behavior of women entrepreneurs and reported that nearly half (48.60%) of the women entrepreneurs had medium risk-bearing ability, followed by low (34.60%) and high (12.70%) risk-taking ability. Nargave (2016) revealed that the majority (55.84%) of the respondents belonged to the young age group, whereas 27.50 per cent and 16.66 per cent of respondents belonged to the middle and old age groups, respectively. Shivacharan *et al.* (2017) observed that the majority (65.84%) of rural young agripreneurs were educated up to college level and above, and the rest of them had high school education (34.16%). Maratha and Badodiya (2017), in a study on marketing behavior and other attributes of vegetable growers in the Kota block of Kota district in Rajasthan, reported that the majority (60.00%) of the respondents were middle-aged, followed by young (21.67%) and old (18.33%). Sadashive *et al.* (2017) observed that 45.83 per cent of the respondents had a high level of economic motivation, whereas 32.50 per cent of them had a medium level of economic motivation, followed by 21.67 per cent of the respondents having a low level of economic motivation. Deepthi *et al.* (2018) studied the profile characteristics of agripreneurs in Andhra Pradesh and reported that two-fourths (54.58%) of the agripreneurs had a medium level of social participation, followed by low (30.42%) and high (15.00%) levels of social participation. Sharma and Hussain (2018)

found that the majority of the respondents (40.00%) belonged to the middle age group, followed by young age (36.0%) and old age (24.00%). Haneef and Ahmad (2021), in a study of Uttarakhand and Punjab State of India, discovered that the majority of respondents (65.83%) belonged to the middle age group of 29–40 years, were married (75.83%), and had a low level of experience (0–5 years) in the agri-enterprise.

Constraints of agripreneurs: Priyatharsni (2003) concluded that the major problems faced by the members were a lack of marketing channels, followed by the delaying of loans from banks, a lack of infrastructure facilities, and insufficient credit facilities. Shekhar (2009) revealed that the major problems expressed by chilli growers in marketing were price manipulation by commission agents (94.38%), high cost of critical inputs (89.38%), inadequate availability of critical inputs (88.75%), price fluctuations (81.25%), lack of cold storage facilities (76.25%) and lack of processing units, value addition centers (75.00%), lack of transport facilities (70.00%), lack of market information from the extension personnel (65.63%), lack of remunerative prices (60.63%), malpractices in weighing of produce (56.88%), markets were located far away from the place of production (56.88%), and improper facilities in the market (56.88%). Sujaivelu and Kanagasabapathi (2013) revealed that marketing constraints were expressed as the major constraint (83.50%), followed by economic constraints (83.91%). The other constraints reported by the respondents were extension constraints (80.99%), physical constraints (75.00%), technological constraints (70.83%), and personal constraints (67.32%). Maratha (2015) revealed that fluctuation in the market price (87.50%), followed by lack of market information and high commission charges (77.50%), lack of processing facilities (67.50%), faulty system of weighing (57.50%), delayed cash payment (51.16%), high cost of transportation (45.00%), absence of storage facilities (43.33%), followed by distance from markets (30.00%) and lack of grading facilities (21.66%) were the major problems faced by farmers in marketing their produce. Tripathi and Agarwal (2015) conducted a study on rural development through agripreneurship in Uttar Pradesh, and they found that barriers faced by agripreneurs were lack of funds, lack of infrastructure, management problems, marketing problems, and competition. Mubeena (2017) reported that the major problems perceived by women entrepreneurs were marketing constraints and a lack of retail shops for selling (33.33%), followed by a lack of local general stores for selling (29.16%).

Agripreneurs and agripreneurship

Agripreneurship is defined as "'generally, sustainable, community-oriented, directly-marketed agriculture. Sustainable agriculture denotes a holistic, system-oriented approach to farming that focuses on the interrelationships of social, economic, and environmental processes.

(Nagalakshmi and Sudhakar, 2013). Agripreneur is defined as an "entrepreneur whose main business is agriculture or agriculture-related." Agriculture + Entrepreneur = Agripreneur. An agricultural entrepreneur is a person who organizes, manages, and assumes the risk of an agro-enterprise. Entrepreneurs are self-employed and income-generating people. In India, 52 per cent of the total land is cultivable, compared to 11 per cent in the world. A large population of India is dependent on agriculture as a source of revenue, but Indian agriculture is low in productivity, with a large number of disguised unemployment. There is a great scope for entrepreneurship in agriculture, and this potential can be tapped only by effective management of different components by an individual with risk-bearing capacity and a quest for the latest knowledge in the agriculture sector to prove themselves as righteous agripreneurs. An agripreneur may start a new agribusiness, change a business direction, acquire a business, or be involved in creating innovations in value addition.

Types of agri-enterprises

According to **Uplaonkar and Biradar (2015),** different types of enterprises in agri-entrepreneurship exist, which are as follows:

- **Farm-level producers: here, the family** is treated as an enterprise for augmenting production by utilizing the high level of technology, possessions, and demand in the
- **Service providers:** There are varied categories of services indispensable in the village. These include input borrowing and distribution and the employment of equipment such as tractors, sprayers, seed drills, threshers, and harvesters ‘dryers. It also consists of scientific services, for example, the setting up of irrigation facilities, weed curbs, plant security, yielding, threshing, conveyance, warehouse, etc., and related opportunities present in the livestock husbandry region for breeding, immunization, disease diagnostic and treatment services, along with the provision of cattle feed, mineral combinations, forage grains, etc.
- **Input producers:** There are many booming enterprises that require significant contribution, and such inputs can be produced by the home entrepreneurs at the village level: biopesticides, soil amendments, biofertilizers, vermicompost, plants of diverse species of vegetables, fruits, ornamentals, root media for raising plants in pots, production of cattle feed concentrate, agricultural tools, irrigation accessories, mineral mixtures, and complete Additionally, opportunities are available in fisheries, sericulture, and poultry as well.
- **Processing and marketing of farm produce:** Well-organized post-production management requires more investment as well as highly qualified and skilled personnel. Societies, cooperatives, and service joint stock companies are examples of people's organizations that can control such businesses. The fruit growers' cooperative, dairy

cooperative, and sugar cooperative are the most successful examples.

Conclusion

The process of spotting business opportunities, gathering the necessary means to explore them, and investing those resources to take advantage of the prospects for long-term profits is known as entrepreneurship. It entails generating income by combining resources in novel ways to launch and run a business. Being an entrepreneur is having the ability to create ideas and make them successful. Among the elements needed to build a sustainable business are creativity, adaptability to change and risk, and resource management. The ability to exploit any industry or business, create jobs, and be competitive are all products of the entrepreneurial spirit. Entrepreneurs are innovators who use the process of shattering the status quo of existing products and services to set up new products and services. An entrepreneur is a person with a high need for achievement who is energetic and a moderate risk-taker.

The role of entrepreneurship in agriculture development is most important, as it catalyzes innovation, sustainability, and economic growth within the sector. Entrepreneurial ventures in agriculture bring out new ideas, technologies, and business models that not only enhance productivity but also contribute to the overall well-being of rural communities.

Agricultural entrepreneurs are at the forefront of adopting and implementing advanced technologies that revolutionize the way farming is conducted.

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Etho-nutritional response of female white New Zealand rabbits during different quarters of the day

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Abstract

Twelve non-lactating female White New Zealand rabbits (3.25 ± 0.20 kg) were randomly selected and housed in separate cages without routine exercise and given 350 g of concentrates and alfalfa green food (ad-lib). An eight-day adaptation period was followed by a five-day behaviour experiment. The animals were observed for their general, specific, and excretion behaviors for 120 consecutive hours, divided into 24 slots of 5 hours each. The animals were observed at an interval of 15 minutes to fill up the behaviour inventory. The data was classified into four quarters of the day, i.e., morning (4–10 hours), noon (10–16 hours), evening (16–22 hours), and night (22-4 hours). For comparing the data, a two-way ANOVA with the replication technique was implemented. The highest sitting posture in the noon (85.69±1.66 m) and standing in the night (85.69±1.66 m); sleeping time in the noon (52.08±1.50 m), eating in the evening (20.00±1.94m), and resting in the night (70.97±2.08 m); and the highest frequency of faecal excretion in the morning (0.63±0.06 times per hour) and urine excretion in the night quarter (0.55+0.08 times per hour) were recorded. It can be concluded that one important component influencing the rabbit's behavior is the effect of different quarters of the day. In the quarter of the night, the rabbits were most active, followed by the morning and evening, whereas in the noon quarter of the day, they were least active.

Keywords: Behaviour, Excretion, Rabbits, Sitting, Standing.

Introduction

The rabbits have attracted the attention of the research worker because of low input and high output potential. The rabbits are kept of multiple production. Because the rabbits are nocturnal animals, therefore they are very sensitive towards the light

intensity humidity, temperature, and clock timings (Szendrő et al., 2016; Kishore and Goitom, 2021a). The domestic rabbit behaviour is still much like that of the wild rabbit (Lebas et al., 1986), since many of the behavioural events which have been reported for wild rabbits are observed in domestic rabbits (Stoufflet and Caillol, 1988).

General behaviour including sitting and standing, specific behaviour including sleeping eating and resting and excretion behaviour including faecal and urine excretion behaviour have been studied in the rabbits according to the clock timings (Kishore and Goitom, 2022). Thermal effect is one of the important factors which affects the behaviour of the rabbit (Kishore and Goitom, 2021b) and found most active at the time when the environmental temperature was low (minimum of 16.9°C during the experiment).

Seasonal variations in the length of the day lighting period have an impact on rabbit behavior, physiological parameters, reproductive health, and other productive functions. The seasons regulate the reproductive process of European wild rabbits, ensuring that the doe that is pregnant or nursing and her offspring have access to enough food (Boyd and Bray, 1989). The lighting schedules in rabbit houses and the natural photoperiod may play important roles in qualities like reproduction. There are still unanswered concerns about the impact of color and intensity. The sensitivity of rabbits to the colour of the light has also been documented (Pan et al., 2022).

Present investigation was conducted with objective to study the etho-nutritional response of Female White New Zealand rabbits during different quarters of the day.

Materials and methods

The field trial was conducted at Rabbit Farm, Hamelmalo Agricultural College (HAC), Hamelmalo, Keren, Zoba Anseba, Eritrea. The farm is located at an altitude of 1286 m above sea level. It has a semi-arid climate with an annual mean rainfall of 440 mm and an average annual temperature of 24 °C. The experiment was conducted in April and May 2018. The experimental animal for research work was a rabbit. From the HAC rabbit farm, 12 non-lactating female White New Zealand rabbits were randomly selected (3.25±0.20 kg) and housed in a separate cage. During the experiment, the animals were not allowed to do routine exercise. The experimental animals were given 350 g of concentrates produced from leftover HAC cafeteria food to suit their daily ME and DCP requirements (Cheeke, 1987; Maertens, 1992). The animal was given green food on an as-needed basis. Along with the concentrate, 3 g of regular salt were given to each animal. Table 1 displays the chemical makeup of feed ingredients (AOAC, 2000).

During the experiment, an eight-day adaptation period was followed by a five-day behaviour experiment. The animals were observed for their general, specific nutritional, excretion, and urination behaviours. The behaviour experiment continued for 120 consecutive hours, divided into 24 slots of 5 hours each. The animals were offered a measured amount of feed at the start of the slot. They had free access to drinking water around the clock. During each slot, the animals were observed at an interval of 15 minutes to fill up the behaviour inventory (Kishore, 1997), including various aspects related to general, specific, nutritional, excretion, and urination behaviour. The recorded data was

classified into four quarters of the day, i.e., morning (4–10 hours), noon (10–16 hours), evening (16–22 hours), and night (22-4 hours). For comparing the data, a two-way ANOVA with replication technique was implemented (Snedecor and Cochran, 1994). The data analysis pack of MS Office Excel 2016 was used for this purpose (UQ Library, 2016).

Table 1: Chemical composition of feed ingredients.

Nutrient	Concentrate	Alfalfa
CP (%)	12.0	18.8
CF (%)	0.9	28.1
EE (%)	0.6	0.6
NFE (%)	85.2	42.2
Ash (%)	1.8	10.4
OM (%)	98.2	89.6
TCHO (%)	85.6	70.3
NFE (%)	84.7	42.2
GE (K cal/g)	4.2	3.9

Results and discussion

During the experimental trial, observed behaviour data of rabbits under study, were classified with regard to the different quarters of the day viz. morning (4-10h), noon (10-16h), evening (16-4h). The quarterly effect of the day had been found to change rabbit behaviour. The results in detailed are presented in this chapter.

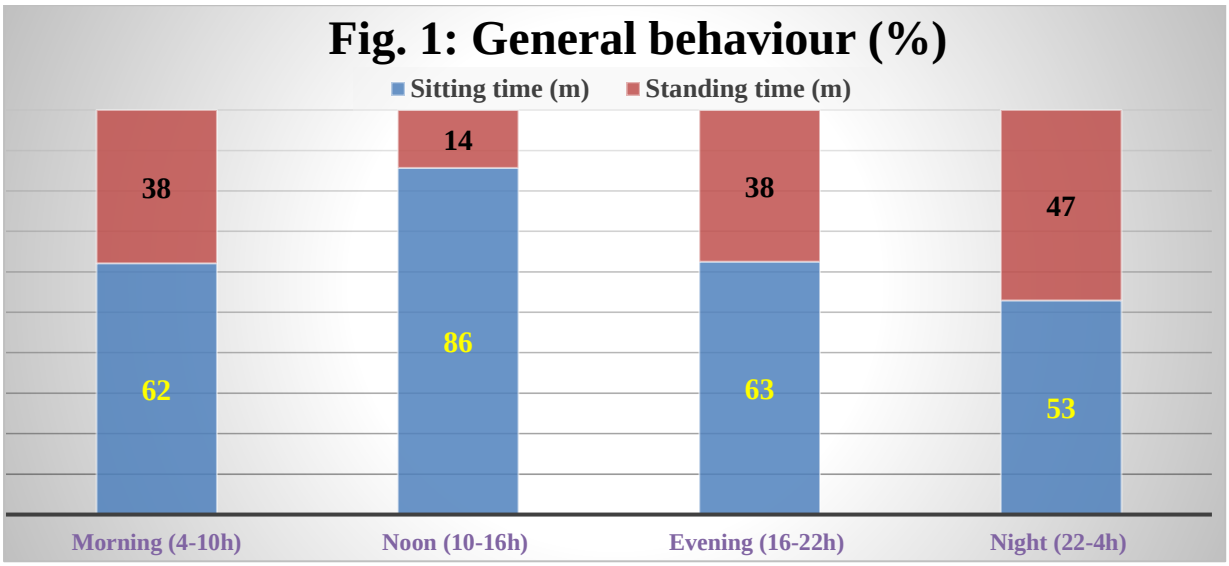
General behaviour: The quarterly effect of the day has been recorded as a key factor that had a significant role in changing the general behaviour of the female White New Zealand rabbits (table 1; Fig. 1). During noon, the animal remained in sitting posture for more time when they stayed for 85.69±1.66 minutes (m), followed by evening (62.50±3.07 m) and morning (62.08±3.09 m), whereas the lowest sitting was recorded during the night (52.92±2.62 m) quarts of the day ($P<0.01$). Just a reverse trend was observed for their standing posture, which was observed highest in the night when the animals stood for more time (85.69±1.66 m), followed by morning (62.50±3.07 m) and evening (62.08±3.09 m), whereas the lowest standing was recorded during the noon (52.92±2.62 m) quarts of the day ($P<0.01$). The results indicated that animals were most active during the night and less active during the noon sessions of the day. The findings indicate that the rabbits are nocturnal and active in dark hours (Lebas, 1997).

Specific behaviour: The specific behaviour of the female White New Zealand rabbits was shown to have significantly ($P<0.01$) changed with the change in the quarter of the day (table 1; Fig. 2). The animal spent the most time sleeping (52.08±1.50 m) during the noon, followed by the time spent during the morning (23.89±2.61 m) and evening (12.78±2.35 m), whereas it spent the least sleeping time at night (11.81±2.01 m). The animal ate the food for the longest time during the evening (20.00±1.94m),

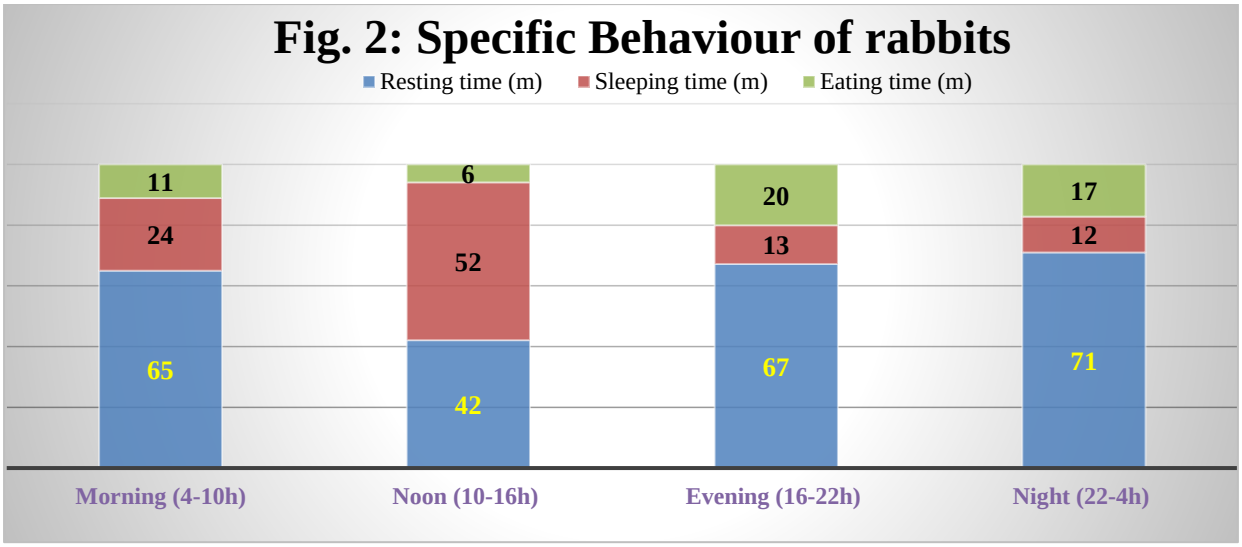
followed by that in the night (17.22±2.06m) and morning (11.11±0.41m), whereas it ate it for the least time at noon (5.83±1.14). The animal rested for the largest period of time in the night (70.97±2.08 m), followed by that in the evening (67.22±2.33 m) and morning (65.00±2.42 m), whereas it rested for the shortest period of time at noon (42.08±1.98 m). According to studies conducted on ruminants (Singh et al., 1997; Srivastava et al., 1997; Kishore, A., 1998; Chandra and Kishore, 2000), the results were contradictory. One possible explanation is that although rabbits were nocturnal, ruminants were not (Lebas et al., 1997). The current research supports the conclusions reached by Prud'hon (1975) and Eberhart (1980). The findings showed that the animals favored to eat in the evening and at night and to sleep in the midday hours of the day.

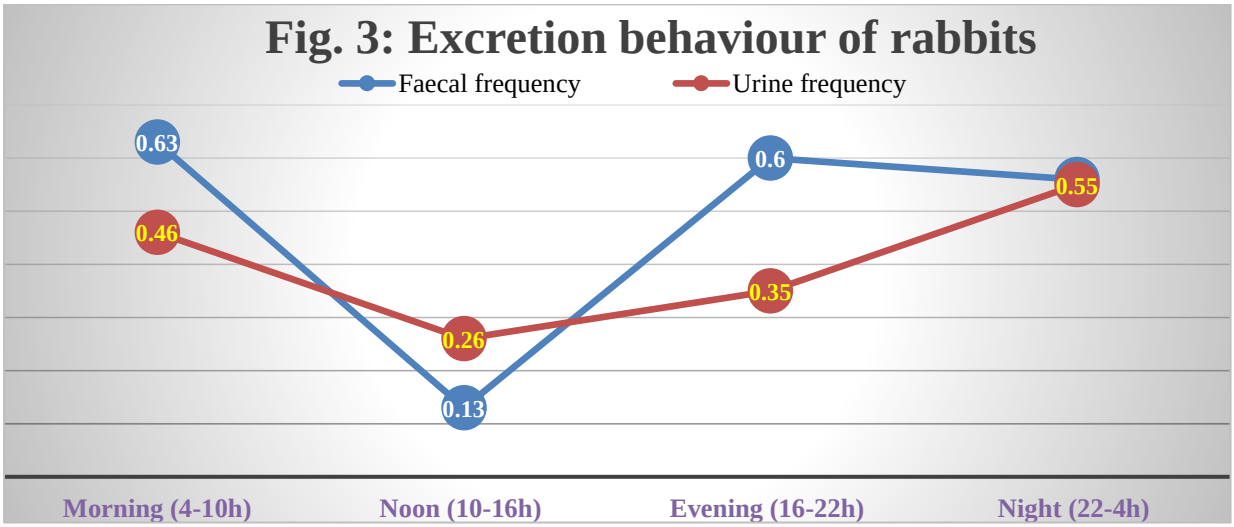
Table 1. Etho-nutitional details of female white New Zealand rabbits

Ethogram parameter		Morning (4-10h)	Noon (10-16h)	Evening (16-22h)	Night (22-4h)	P-value
General behaviour	Sitting time (m)	62.08±3.09	85.69±1.66	62.50±3.07	52.92±2.62	0.00
	Standing time (m)	37.92±3.09	14.31±1.66	37.50±3.07	47.08±2.62	0.00
Specific behaviour	Resting time (m)	65.00±2.42	42.08±1.98	67.22±2.33	70.97±2.08	0.00
	Sleeping time (m)	23.89±2.61	52.08±1.50	12.78±2.35	11.81±2.01	0.00
	Eating time (m)	11.11±0.41	5.83±1.14	20.00±1.94	17.22±2.06	0.00
excretion behaviour	Faecal frequency	0.63±0.06	0.13±0.03	0.60±0.11	0.56±0.08	0.00
	Urine frequency	0.46+0.07	0.26±0.06	0.35±0.08	0.55+0.08	0.00



Excretion behaviour: The day's quarterly effect had been noted, influencing the rabbits' excretion habits (table 1; Fig. 3). The morning quarter had the highest frequency of faecal excretion (0.63±0.06 times), followed by the evening (0.60±0.11 times) and night (0.56±0.08 times). The midday quarter had the lowest frequency of faecal excretion (0.13±0.03 times). The quarter with the highest frequency of urine excretion was the night quarter (0.55+0.08 times), followed by the morning (0.46+0.07 times) and evening (0.35±0.08 times). The quarter with the lowest frequency of urine excretion was the midday quarter (0.26±0.06 times). The findings on the same line with the ruminants (Singh et al., 1997; Srivastava et al., 1997; Kishore, 1998; Chandra and Kishore, 2000) were at odds with the results. One possible explanation is that although rabbits were nocturnal, ruminants were not (Lebas et al., 1997). The paucity of available literature made it impossible to verify the recorded figures.





Conclusion

Based on the results of this study, it can be concluded that one important component influencing the rabbit's behavior is the effect of different quarters of the day. In the quarter of the night, the rabbits were most active, followed by the morning and evening, whereas in the noon quarter of the day, they were least active. The time spent on eating was also high during the quarters of evening and night. Thus, a feeding plan can be recommended in order to plan the eating times of rabbits, particularly during the evening and night quarters.

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Impact of milk fat content on the physico-chemical, and sensory characteristics of paneer

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Abstract

The present investigation was conducted to find out the impact of milk fat content on the physico-chemical and sensory characteristics of paneer. Fresh cow and buffalo milk from nearby dairies was collected and separated in the laboratory. Cow and buffalo skim milk and creams were also used to standardize milk at various fat levels according to the needs of the experiments, i.e., buffalo milk testing 6.0 and cow milk testing 5.0, 4.5, 3.5, and 2.5% fat. As a coagulating agent, a 2.0% (w/v) concentration of synthetic citric acid was employed. The temperature of 80°C was reached after the coagulation process was finished. To make each batch of paneer, many three-liter batches of homogenized milk were prepared. The standard process was used to make the paneer, and yields were noted. Yield, moisture, titratable acidity, pH, fat, FDM, protein, lactose, ash, calcium, and phosphorus were among the chemical parameters examined for the paneer samples. Suitable methods of statistical analysis were applied to the data collected during the current study. The conclusion was that the decrease in the fat content of the milk used to prepare paneer declined in appearance, body and texture, color, taste, flavor, and overall acceptability; however, the variations in milk fat levels had no effect on the moisture absorption properties of paneer or the quantity of coagulants needed for milk coagulation.

Keywords: cow milk, dairy milk, paneer, physico-chemical characteristics, sensory characteristics.

Introduction

Paneer is a type of fresh, soft, unripened cheese made by the acid-heat coagulation of milk. It is quite popular in the Indian sub-continent and is used to prepare various culinary dishes and snacks. Paneer is highly nutritious and is rich in proteins, fats,

vitamins, and minerals like calcium and phosphorous (Rai et al., 2014). Over the past few years, there has been a continuous attempt to produce paneer in various forms such as long-life paneer, low-fat paneer, UF paneer, and paneer-like products through the utilization of various vegetable proteins and fats There is a constant urge for the development of low-fat paneer preferably from cow milk as cow milk contains low fat compared to buffalo milk. Such type of paneer will not only fulfil the increasing demand for paneer especially to the fat-conscious consumer but also utilizes a significant part of surplus skim milk. The development of paneer from low-fat milk results in the formation of paneer having a hard body, rubbery, coarse, bland flavor, poor mouthfeel, chewy texture, mottled color, and appearance (Kant et al., 2024).

The level of fat in milk had a significant ($P<0.01$) effect on yield, and nutrients recovered. Paneer yield and recovery of fat, protein, and total solids decreased with the decrease in the level of fat in milk used for preparing paneer. A decrease in the level of fat in milk increased the contents of moisture, fat, calcium, and phosphorus; decreased FDM, and could not affect pH, protein lactose, and ash in manufactured paneer(Kumar and Singh, 2013).

Present investigate was conducted to study the impact of milk fat content on the physico-chemical, and sensory characteristics of paneer.

Materials and Methods

In order to prepare paneer, a coagulated milk product, fresh cow and buffalo milk from nearby dairies were separated in the laboratory for the current investigation. Cow and buffalo skim milk and creams were also used to standardize milk at various fat levels according to the needs of the experiments, i.e., buffalo milk testing 6 (control) and cow milk testing 5.0, 4.5, 3.5, and 2.5% fat. As a coagulating agent, a 2.0% (w/v) concentration of synthetic citric acid was employed. The temperature of 80°C was reached after the coagulation process was finished. To make each batch of paneer, many three-liter batches of homogenized milk were prepared. The process of Bhattacharya et al. (1971), as modified by Sachdeva (1983), was used to make the milk product from standardized milk, and yields were noted. Yield, moisture, titratable acidity, pH, fat, FDM, protein, lactose, ash, calcium, and phosphorus were among the chemical parameters examined for the paneer samples (AOAC 1980, ISI 1973, ISI 1977, and ISI 1981). Snedecor and Cochran (1994) methods of statistical analysis were applied to the data collected during the current study.

Results and discussion

Physico-chemical properties of paneer

For paneer prepared from milk, the moisture absorption (% green weight) was 11.91±0.97, 11.98±0.63, 11.9±0.27, 11.66±0.01, and 11.81±0.59%, with corresponding fat percentages of 6.0, 5%, 4.5, 3.5, and 2.5% in raw milk (Table 1). The final product generated from milk with different levels of milk fat did not differ significantly in terms of moisture absorption. The consistent moisture absorption value seen in all samples may be the result of paneer being saturated with water, which could explain this phenomenon. When the amount of fat in the milk used to make paneer decreases, there is no discernible trend in the moisture absorption (%green weight) of the product. The results regarding paneer's ability to

absorb moisture were in line with previous reports (Arora and Gupta, 1980; Parmar et al., 1989; Gupta et al., 1992; Agnihotri and Pal, 1996; Pal and Kapoor, 2000; Farooquei et al., 2008; Kumar et al., 2008; Das and Das, 2009; Harjai et al., 2009; Nalkar et al., 2009a; Nalkar et al., 2009b; Pawar et al., 2011). Regarding low-fat paneer, the results of this investigation corroborated the findings previously published in this regard (Pal et al., 1991; Sanyal and Yadav, 2000a; Kumar et al., 2007; Kandeepan and Sangma, 2011). All the milk varieties used to make paneer had similar coagulation temperatures and times, which may have contributed to the nearly identical moisture absorption in the final product.

Table 1: Effect of Fat Levels in Milk on Physico-Chemical Properties of Paneer

Parameters	6.0% fat	5% fat	4.5% fat	3.5% fat	2.5% fat
Moisture absorption (%)	11.91±0.97	11.98±0.63	11.90±0.27	11.66±0.01	11.81±0.59
Coagulant (ml)	70.00±0.17	73.00±0.41	75.00±0.71	78.00±0.73	80.00±0.69
Appearance scores	4.89±0.13 ^{C}	4.29±0.08 ^{B,C}	4.05±0.12 ^{B}	2.38±0.03 ^{A}	2.46±0.09 ^{A}

^{A,B,C} *Values bearing different superscripts within the row differed significantly (P<0.05).*

For paneer that was made from milk, the amounts of coagulant needed for optimal coagulation were 70.00±0.17, 73.00±0.41, 75.00±0.71, 78.00±0.76, and 80.00±0.69 ml, testing 6.0, 5.0, 4.5, 3.5, and 2.5% fat, respectively. The amount of coagulant needed to coagulate the milk was not significantly affected by the fat content of the milk. However, throughout the current experiment, the trend of data for this very measure showed a negative relationship with the amount of fat in milk. As a result, it was observed that the amount of coagulant (ml) needed seemed to grow as raw milk's fat content decreased. According to some theories, casein, acid phosphate, citrates, and other minerals contribute to milk's natural acidity, which is thought to be higher in milk that has been standardized to include up to 3.5% fat than in milk with lower fat content. This could be the cause of the greater coagulant (mL) required in low-fat therapy regimens that are standardized. These results are consistent with those of Pal et al. (1991), who similarly observed a comparatively higher amount of coagulant need with a drop in milk fat levels, despite the paucity of literature to support and validate this theory. All the varieties of milk used to make paneer had similar coagulant types and extents, as well as coagulation temperatures and times, which is why the study's results were nearly identical. The paneer manufactured from milk with 6.0, 5.0, 4.5, 3.5, and 2.5% fat, respectively, had appearance scores of 4.89±0.13, 4.29±0.08, 4.05±0.12, 2.38±0.03, and 2.46±0.09. There were notable differences in the amount of fat in milk (P<0.01). When paneers were tested at 6% fat, the greatest appearance ratings were obtained; when paneers were tested at 2.5% fat, the lowest appearance scores were obtained. When paneer manufactured from milk was tested at 2.5 and 3.5%, 4.5 and 5%, and 5 and 6% fat, the results did not differ significantly from one another. The results described before (Arora and Gupta, 1980; Agnihotri and Pal, 1996; Bhadekar et al., 2008; Kumar et al., 2008; Rupnar et al., 2009) are supported by the current findings about the

appearance of paneer. Regarding low-fat paneer, the results of this investigation corroborated the findings published previously (Sanyal and Yadav, 2000a; Kumar et al., 2007). When paneer was made with low-fat milk, its appearance scores dropped. It might be because there isn't much of this nutrient in the final product.

Sensory Attributes of Paneer

A product's sensory qualities are extremely important since they draw customers in and, in some cases, safeguard their interests. Customers typically assess a product's quality based on its look, smell, body, texture, and taste, among other physical characteristics. A high-quality paneer is distinguished by its white hue, characteristic acidic flavor with a hint of sweetness, firm, cohesive, and spongy body, and smooth, densely knit texture. During the current experiment, paneer made from milk with different fat contents was not only evaluated sensory using a 5-point hedonic scale that ranged from outstanding (scoring 5) to fair (score 1). The following headings give a summary of the findings thus far in this regard. In paneer made from milk containing 6.0, 5.0, 4.5, 3.5, and 2.5% fat, respectively, the body and texture ratings were 4.02±0.11, 3.66±0.07, 3.29±0.1, 2±0.03, and 2.31±0.08 (Table 2). According to the findings in this area, the amount of fat in the milk had a noteworthy ($P<0.05$) impact on the paneer's body and texture characteristics. Moreover, it is evident that raising the fat content of milk significantly enhances the body and texture of paneer. However, it seems that reducing the fat content of milk by up to 3.5% resulted in a product with decent body and texture. However, the further decrease in milk fat produced paneer with a fair body and texture. This proved that the fat content of the raw milk added to the paneer's richness. The decrease in fat content in the milk used to make paneers indicates a downward trend in the body and texture scores of these milk products. The current research on the body and texture scores of paneers supported the findings published in previous studies (Arora and Gupta, 1980; Mistry et al., 1990; Gupta et al., 1992; Sharma et al., 1998; Sharma et al., 1999; Uprit and Mishra, 2004; Jayaraj Rao and Patil, 2006; Bhadekar et al., 2008; Kumar et al., 2008; Deshmukh et al., 2009; Mathare et al., 2009; Karadbhajne and Bhoyarkar, 2010; Pawar et al., 2011). The results of this investigation confirmed previous findings for low-fat paneer (Chawla et al., 1985; Desai et al., 1991; Pal et al., 1991; Sanyal and Yadav, 2000a; Sanyal and Yadav, 2000b; Kandeepan and Sangma, 2011).

The paneer samples that tested at 6.0, 5.0, 4.5, 3.5, and 2.5% fat had color scores of 4.25±0.11, 3.53±0.06, 3.5±0.11, 2.73±0.04, and 2.24±0.08, respectively. Creamy white is the typical color of freshly cooked paneer derived from whole fat milk. As the fat content of the milk used to make paneer fell and became much closer to white, the color ratings decreased as well. One possible explanation is that the presence of fat-soluble vitamin A precursor in milk fat gives paneer its creamy white color. The amounts of fat in milk varied considerably ($P<0.05$) from the color ratings of paneer. The paneer prepared from milk with 6% fat had the highest color score, while milk with 2.5% fat had the lowest. As the amount of fat in the milk used to make this milk product decreased, so did the paneer's color scores. The results validated those previously published (Agnihotri and Pal, 1996; Bhadekar et al., 2008; Kumar et al., 2008) findings. Regarding low-fat paneer, the current study's results corroborated

previously published research (Rupnar et al., 2009).

In paneer prepared from milk with fat levels of 6.0, 5.0, 4.5, 3.5, and 2.5 percent, the taste scores were 4.61±0.12, 4.4±0.08, 3.87±0.12, 2.62±0.04, and 1.81±0.06, in that order. Freshly cooked paneer made with whole milk typically has a little sweeter, less sour flavor. As the amount of fat in the milk used to make paneer fell, so did the scores. The explanation could be that paneer made from low-fat milk has less of the lactose and milk fat that give it a nice, sweet taste, which could lead to the product receiving low marks. The amount of fat in milk had a substantial ($P<0.05$) difference in the taste of paneer. The paneers prepared from milk that tested at 6% fat had the highest flavor ratings, while the sample made from milk that tested at 2.5% fat had the lowest. The flavor of paneer manufactured with milk that tested at 5 and 6% fat levels did not differ significantly from one another. Figure 4.4 shows that when the amount of fat in the milk used to make this milk product reduced, so did the paneers' taste scores. The results shown before (Agnihotri and Pal, 1996; Bhadekar et al., 2008; Karadbhajne and Bhoyarkar, 2010; Nawaz et al., 2011) were supported by the current research on paneer flavor. Regarding low-fat paneer, the results of this investigation corroborated the findings published previously (Pal et al., 1991).

When paneer made from milk with 6.0, 5.0, 4.5, 3.5, and 2.5% fat was tested, the flavor score was 4.75±0.25, 4.75±0.25, 4.25±0.48, 3±0.58, and 2.5±0.65. Because diacetyl is present, newly cooked paneer made from full fat milk has a pleasant flavor. As the amount of fat in the milk used to make paneer fell, so did the flavor scores. The final product may have received low ratings because the amount of diacetyl was decreased in paneer made from low-fat milk. The amount of fat in milk had a significant difference ($P<0.05$) in the flavor of paneer. The paneer prepared from milk tested at 6% fat had the highest flavor, whereas milk tested at 2.5% fat yielded the lowest. In tests involving 2.5, 3.5, and 4.5% fat, 5% fat, and 4.5, 5 and 6% fat, the flavor of paneer manufactured from milk did not differ significantly from one another. As the amount of fat in the milk used to make this milk product reduced, so did the flavor of paneer. The current research on paneer flavor validated previously published research in this area (Arora and Gupta, 1980; Mistry et al., 1990; Pandya and Ghodke, 2007; Kumar et al., 2008; Yadav and Grover, 2009; Karadbhajne and Bhoyarkar, 2010; Nawaz et al., 2011). Regarding low-fat paneer, the current study's results corroborated previously published research (Chawla et al., 1985; Sanyal and Yadava, 2000a; Sanyal and Yadav, 2000b).

The paneer made from milk that tested at 6.0, 5.0, 4.5, 3.5, and 2.5 percent fat had overall acceptability values of 4.57±0.12, 4.07±0.07, 3.76±0.11, 2.49±0.03, and 2.26±0.08, in that order. Fresh paneer made with whole milk is suitable due to the combination of its flavor, body, texture, and taste. As the amount of fat in the milk used to make paneer fell, so did the paneer's overall acceptability scores. The cause might be the decreased milk fat in paneer made from low-fat milk, which could result in a low-scoring final product. The amount of fat in milk varied considerably ($P<0.05$) from the paneer's overall acceptability scores. The paneer made with 6% fat in milk had the highest overall acceptability scores, whereas the paneer created with 2.5% fat had the lowest. The paneer prepared from milk was tested at 2.5 and 3.5%, 4.5 and 5%, and 6% fat did not

significantly differ from one another in terms of overall acceptability scores. As the amount of fat in the milk used to make this milk product fell, so did the paneer's overall acceptability scores. The overall acceptance scores supported findings of (Kumar et al., 2008; Rupnar et al., 2009). Regarding low-fat paneer, the results of this investigation corroborated the findings published previously (Pal et al., 1991).

Table 2: Sensory Characteristics of Paneer as Influenced by Varying Milk Fat Levels.

Physical properties	**6.0% fat**	**5% fat**	**4.5% fat**	**3.5% fat**	**2.5% fat**
Body and texture	4.02±0.11 ^{C}	3.66±0.07 ^{B,C}	3.29±0.10 ^{B}	2.00±0.03 ^{A}	2.31±0.08 ^{A}
Colour	4.25±0.11 ^{D}	3.53±0.06 ^{C}	3.50±0.11 ^{C}	2.73±0.04 ^{B}	2.24±0.08 ^{A}
Taste	4.61±0.12 ^{D}	4.40±0.08 ^{C,D}	3.87±0.12^{C}	2.62±0.04 ^{B}	1.81±0.06 ^{A}
Flavour	4.75±0.25 ^{B}	4.75±0.25 ^{B}	4.25±0.48 ^{A,B}	3.00±0.58 ^{A}	2.50±0.65 ^{A}
Overall Acceptability	4.57±0.12 ^{C}	4.07±0.07 ^{B,C}	3.76±0.11 ^{B}	2.49±0.03 ^{A}	2.26±0.08 ^{A}

^{A,B,C,D} *Values bearing different superscripts within the row differed significantly, (P<0.05)*

Conclusion

The findings thus led to the conclusion that decreasing the fat content of the milk used to prepare paneer resulted in a decline in appearance, body and texture, color, taste, flavor, and overall acceptability; on the other hand, the variations in milk fat levels had no effect on the moisture absorption properties of paneer or the quantity of coagulants needed for milk coagulation.

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Blood profile and carcass traits of Kadaknath broilers fed on various levels of azolla (*Azolla pinnata*)

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Abstract

*The present study examined the blood composition and carcass traits of Kadaknath broilers raised in the Poultry Research Centre, School of Agriculture, ITM University, Gwalior, between September and November 2023 for a total of 56 days. They were fed varied amounts of azolla (*Azolla pinnata*) powder. A total of 120 Kadaknath day-old-chicks were divided into 30 flocks. The flocks were randomly allotted to five treatments with six replications. They were housed in a deep litter system with eight hours of darkness and sixteen hours of light. Starter (week 1; 23% CP and 3000 kcal/kg ME), grower (weeks 2–6; 22% and 3100 kcal/kg), and finisher (weeks 7-8; 20% CP and 3200 kcal/kg ME) feeds were provided to the broilers in the control group (Az_{00}). The sun-dried azolla powder replaced the ration in the test groups at 2.5, 5.0, 7.5, and 10.0 per cent in $Az_{2.5}$, $Az_{5.0}$, $Az_{7.5}$, and $Az_{10.0}$, respectively. On the final day of the experiment, the haemeto-biochemical profiles of the blood and carcass characteristics were compared. The blood parameters in $Az_{5.0}$ were higher than the others: PCV (43.40±1.31%), TLC (66.83±0.47 n/µl), TEC (1.40±0.03 n/µl), basophils (1.69±0.04%), heterophils (18.72±0.18%), and haemoglobin (13.77±0.10 g/dl). $Az_{5.0}$ had higher live weight (1151±9 g), dressed weight (888±17 g), eviscerated weight (831±36 g), eviscerated weight (73.1±2.6%), and heart weight (1.65±0.1 g). The study concluded that the broiler ration may be replaced at a 5 per cent level with sun-dried azolla powder to increase the productivity of the Kadaknath broilers.*

Keywords: Azolla, Blood, Broiler, Carcass, Kadaknath.

Introduction

Azolla ferns (*Azolla pinnata*) are rich not only in protein and the necessary amino acid contents but also in minerals and vitamins. The application of azolla to increase poultry production varies (El-Ghany, 2020). Since azolla is an

inexpensive and abundant alternative plant protein source that enhances feed conversion ratio (FCR), energy efficiency, and performance without having a negative impact on chickens, adding it to the diet reduces production cost (Alalade and Lyayi, 2006; Namra *et al*., 2010). The majority of the data indicate improvements in the production of chicken-fed diets containing azolla, despite contradictory findings. According to Sarria and Preston (1995), broiler growth increased when azolla was used in place of soybean protein, up to a 15% level. The body weight at 4, 6, and 8 weeks of age was considerably increased when dietary azolla protein was added to the broiler chicken diet at a level of 6% (Sundararaju *et al*., 1995). The improved FCR have also been reported that following azolla feeding in broiler rations at 5–15% (Ardakani *et al*., 1996) and 5% (Seth *et al*., 2013; Nagshi *et al*., 2014) azolla levels. The growth rate, feed conversion ratio, and energy efficiency of 2 to 6-week-old broilers were enhanced when azolla was added to their diet up to 5% without having a negative impact on the palatability or mortality rates (Basak *et al*., 2002). Because commercial feed might enhance the weight of chickens, it was advised that 20% fresh azolla be used in their meals (Subudhi and Singh, 1978). When Azolla was increased up to 15% (Querubin *et al*., 1986) and 30% (Dhumal *et al*., 2009), a notable variation in feed intake was observed. Adding up to 10% of azolla meal to growing pullet rations is safe and does not pose any health risks (Alalade *et al*., 2007). The group that received supplements containing up to 5% azolla alone experienced increase in body weight gain; however, high concentrations of azolla's fiber severely impact the birds' hunger, which in turn slows down their gain in growth (Saikia *et al*., 2014). Following the addition of azolla to the diet at levels of 5% and 10% (Acharya *et al*., 2015), 7.5% (Kumar *et al*., 2018), and 15% (Samad *et al*., 2020), improvements in body weight gain and FCR were observed. The addition of Azolla at any level significantly decreased the production's feed costs. Azolla supplementation at a modest level of inclusion has been shown to benefit chicken (Bacerra *et al*., 1995), and studies on broilers have shown positive economic returns (Parthasarathy *et al*., 2002). The highest amount of economic advantage was demonstrated by the 10% inclusion of azolla. Due to lower FCR, mortalities, and production costs and higher net profit, it was advised that adding azolla at levels of 5% or 7% is suitable for safe and successful broiler production (Islam and Nishibor, 2017). Contradictorily, the feeding of broilers on azolla resulted in similar body weight and growth as those kept on a maize-soybean meal (Ali and Leeson, 1995) and a decrease in the body weights of broilers (Parthasarathy *et al*., 2002) because of decreased feed intake (Alalade and Lyayi, 2006). A linear reduction was found in feed intake with increasing azolla levels in the chicken broiler diets (Ara *et al*., 2015).

Haematological and biochemical testing may be helpful for diagnosing health, observing how ill birds respond to treatment regimens, and determining the prognosis for specific poultry diseases, even if they have not been widely utilized in avian medicine. By calculating the normal values for hematological and biochemical variables, a comprehensive database for the blood profiles of domestic (Elagib *et al*., 2012) and genetically approved industrial (Talebi *et al*., 2005) poultry species was created. Blood parameter analyses employ standard values for multiple purposes, such as evaluating

health disorders (Harper and Lowe, 1998), predicting potential resistance to environmental conditions (Silversides *et al*., 1997), estimating future body weight (Singh *et al*., 1998), diagnosing diseases (Prameela Rani *et al*., 2011), and assessing poultry immune status (Seiser *et al*., 2000). These data could be used in breeding programs to enhance the genetic composition of native hens, in addition to being beneficial for diagnosis and care (Alewi *et al*., 2012). Comprehending the normal physiological parameters in a given environment is crucial for efficient breeding, nutrition, illness prevention, and treatment.

The Kadaknath chicken is mostly raised by the tribal people who live in the western districts of Madhya Pradesh (Jhabua and Dhar) and the neighboring areas of Gujarat and Rajasthan. This breed yields meat that is dark in color and has a flavorful flesh (Panda and Mahapatra, 1989). Eggs and meat from Kadaknath are considered to be rich sources of protein and iron.

In view of the above, the objective of this investigation was to determine the blood composition and carcass characteristics of Kadaknath chickens fed varying levels of azolla (*Azolla pinnata*).

Materials and Methods

The present work was carried out at the poultry farm of the School of Agriculture, ITM University, Gwalior, situated at 26.140°N and 78.196°E longitude at an altitude of 197 m MSL. The soil is sandy loam in texture with uniform topography. It has a subtropical climate with an average annual rainfall of 700 mm. The summer temperature goes up to 48 °C, and in winter it remains as low as 3°C.

The day-old Kadaknath chicks in a total of 120 were randomly selected and divided into 30 flocks of 4 birds each. The flocks were further randomly allotted to five treatments with six replications. They were tagged with the help of wing banding. The chicks were maintained in a deep litter system of housing with 16 hours of light and 8 hours of darkness. The chicks were vaccinated against Marek's, Ranikhet, and infectious bronchitis diseases on 0, 7, and 14 days, respectively. The experiment was carried out during September and November 2023 and lasted for 56 days.

The broilers in the control group (Az_{00}) were offered a ration containing maize, soybean meal, de-oiled rice bran, stone grit, dicalcium phosphate, NaCl salt, DL-methionine, L-lysine HCl, trace minerals, vitamins A, D_3, K, and B complex, toxin binder, tyrosine, and coccidiostat, maintaining levels of 23% and 3000 kcal/kg during the starter phase (week 1), 22% and 3100 kcal/kg during the grower phase (weeks 2–6), and 20% crude protein and 3200 kcal/kg metabolizable energy during the finisher phase (weeks 7-8), respectively (BIS, 2022). The ration was replaced in test groups with sun-dried azolla powder at a level of 2.5, 5.0, 7.5, and 10.0 percent in $Az_{2.5}$, $Az_{5.0}$, $Az_{7.5}$, and $Az_{10.0}$, respectively.

The heparinized blood samples from one chicken selected randomly from each flock were drawn on the last day of the experiment. The hematological parameters RBCs (million/mm³ or million/µl), WBCs (thousand/mm³ or thousand/µl), DLC (%), Hb (g/dl), PCV (%), MCV (µ³), MCH (pg/cell), and MCHC (g/dl) were recorded in the blood samples. Blood drawn was subjected to estimation of hematological parameters by using an auto-hematology analyzer. Differential WBC counts were

made on monolayer blood films and stained using Giemsa stain after fixing them with methyl alcohol.

Biochemical parameters were recorded from serum isolated from the blood sample collected from six birds in each group. The blood samples were collected in a sterile vial and kept in a slating position for 30 minutes, followed by centrifugation at 2000 rpm for 15 minutes. The biochemical parameters included total protein, albumin, globulin, AG ratio, serum glutamic oxaloacetic transaminase (SGOT), serum glutamic-pyruvic transaminase (SGPT), cholesterol, bilirubin, blood urea nitrogen (BUN), and creatinine by using a standard diagnostic kit (Erba Pvt. Ltd.).

One bird from each flock was randomly selected to be sacrificed for finding out the carcass traits of Kadaknath broilers on the last day of the experiment.

The data obtained were analyzed using the analysis of variance (ANOVA) single factor following the procedure of Snedecor and Cochran (1994). The data analysis pack of MS Office Excel 2016 was used for this purpose (UQ Library, 2016).

Results and Discussion

Table 1 shows the impact of azolla levels on the haemato-biochemical profile of Kadaknath broilers. Blood haemoglobin levels in Kadaknath broilers were found to be significantly higher ($P<0.01$) in $_{5.0}$ and lower in Az_{00}, with the values of 11.30±0.17 in Az_{00}, 12.40±0.15 in $Az_{2.5}$, 13.77±0.10 in $Az_{5.0}$, 11.86±0.12 in $Az_{7.5}$, and 11.68±0.17 g/dl in $Az_{10.0}$. The findings suggested that azolla can replace poultry ration up to a 5 per cent level, with an increasing trend followed by a declining one. The same trends were observed in the levels of monocytes (1.96±0.05 in Az_{00}; 3.29±0.09 in $Az_{2.5}$; 5.67±0.15 in $Az_{5.0}$; 3.64±0.10 in $Az_{7.5}$; 3.65±0.10% in $Az_{10.0}$), basophils (1.56±0.04 in Az_{00}; 1.48±0.04 in $Az_{2.5}$; 1.69±0.04 in $Az_{5.0}$; 1.52±0.07 in $Az_{7.5}$; 1.54±0.08% in $Az_{10.0}$), heterophils (15.72±0.15 in Az_{00}; 16.37±0.16 in $Az_{2.5}$; 18.72±0.18 in $Az_{5.0}$; 18.36±0.18 in $Az_{7.5}$; 18.34±0.18% in $Az_{10.0}$), TLC (58.53±0.41 in Az_{00}; 60.63±0.43 in $Az_{2.5}$; 66.83±0.47 in $Az_{5.0}$; 61.61±0.43 in $Az_{7.5}$; 61.59±0.43 n/µl in $Az_{10.0}$) and TEC (0.98±0.03 in Az_{00}; 1.21±0.03 in $Az_{2.5}$; 1.40±0.03 in $Az_{5.0}$; 1.15±0.03 in $Az_{7.5}$; 1.13±0.03 n/µl in $Az_{10.0}$) in the blood of Kadaknath broiler. Blood basophil level in the blood of Kadaknath broilers (1.56±0.04 in Az_{00}, 1.48±0.04 in $Az_{2.5}$, 1.69±0.04 in $Az_{5.0}$, 1.52±0.07 in $Az_{7.5}$, and 1.54±0.08% in $Az_{10.0}$) was found to be significantly higher ($P<0.01$) in $Az_{5.0}$ and lower in $Az_{7.5}$. The results reported that azolla replacement up to a level of 5% of the concentrate increased basophil levels, and then the same decreased with no specific trend. Blood eosinophil levels in Kadaknath broilers were found to be significantly higher ($P<0.01$) in $Az_{7.5}$ and lower in Az_{00}, with values of 1.62±0.05 in Az_{00}, 1.96±0.06 in $Az_{2.5}$, 2.00±0.06 in $Az_{5.0}$, 2.31±0.07 in $Az_{7.5}$, and 2.32±0.07 per cent in $Az_{10.0}$. The findings showed that azolla can replace poultry rations up to a 7.5 per cent level, with an increasing trend followed by a declining one. Blood PCV level in the Kadaknath broilers (39.23±1.18 in Az_{00}, 40.31±1.22 in $Az_{2.5}$, 43.40±1.31 in $Az_{5.0}$, 37.45±1.13 in $Az_{7.5}$, and 37.42±1.13% in $Az_{10.0}$) was found to be significantly higher ($P<0.01$) in $Az_{5.0}$ and lower in $Az_{10.0}$. The results reported that azolla replacement up to a level of 5% of the concentrate increased PCV levels and then declined. The H-L ratio in the Kadaknath blood was higher in $Az_{10.0}$ and in Az_{00}, with the values

0.15±0.03, 0.17±0.01, 0.22±0.01, 0.22±0.01, and 0.25±0.01 in Az_{00}, $Az_{2.5}$, $Az_{5.0}$, $Az_{7.5}$, and $Az_{10.0}$, respectively. It can be presumed that the increased level of replacement of ration with azolla caused an increase in the H-L ratio in the blood of Kadaknath broilers.

The current study's results closely align with those of Kamel and Hamad (2021), who found that, when compared to the control group, dietary dried Azolla significantly improved several haemato-biochemical parameters at different levels, but the PCV value showed no significant difference. When compared to the control group, all groups fed DA had higher Hb and TLC levels. The high phenolic and flavonoid content of Azolla may be the cause of this increased value. However, Mishra *et al*. (2016) reported that birds given Azolla at levels of 5 and 7.5% had greater values of lymphocytes and heterophils than the control birds. According to Thavasi *et al*. (2020), the PCV and RBC of the birds given a meal supplemented with 5% Azolla showed substantial increases. These outcomes concur with those of Kumar *et al*. (2018), who found no differences in the levels of HB, heterophils, and TLC when DA was supplemented at 2.5, 5, 7.5, and 10%.

Table 1. Effect of Azolla levels on haemato-bichemical profile of Kadaknath broilers.

Parameter	Azolla (*Azolla pinnata*) levels					
	Az_{00}	$Az_{2.5}$	$Az_{5.0}$	$Az_{7.5}$	$Az_{10.0}$	*P-Value*
Heamoglobin (g/dl)	$11.30±0.17^{d}$	$12.40±0.15^{b}$	$13.77±0.10^{a}$	$11.86±0.12^{c}$	$11.68±0.17^{c}$	**
Eosinophils (%)	$1.62±0.05^{c}$	$1.96±0.06^{b}$	$2.00±0.06^{b}$	$2.31±0.07^{a}$	$2.32±0.07^{a}$	**
Monocytes (%)	$1.96±0.05^{d}$	$3.29±0.09^{c}$	$5.67±0.15^{a}$	$3.64±0.10^{b}$	$3.65±0.10^{b}$	**
Basophils (%)	$1.56±0.04^{ab}$	$1.48±0.04^{b}$	$1.69±0.04^{a}$	$1.52±0.07^{b}$	$1.54±0.08^{b}$	**
Heterophils (%)	$15.72±0.15^{b}$	$16.37±0.16^{b}$	$18.72±0.18^{a}$	$18.36±0.18^{a}$	$18.34±0.18^{a}$	**
PCV (%)	$39.23±1.18^{ab}$	$40.31±1.22^{ab}$	$43.40±1.31^{a}$	$37.45±1.13^{b}$	$37.42±1.13^{b}$	**
TLC (n/µl)	$58.53±0.41^{c}$	$60.63±0.43^{b}$	$66.83±0.47^{a}$	$61.61±0.43^{b}$	$61.59±0.43^{b}$	**
TEC (n/µl)	$0.98±0.03^{c}$	$1.21±0.03^{b}$	$1.40±0.03^{a}$	$1.15±0.03^{b}$	$1.13±0.03^{b}$	**
HL ratio	$0.15±0.03^{c}$	$0.17±0.01^{c}$	$0.22±0.01^{b}$	$0.22±0.01^{b}$	$0.25±0.01^{a}$	**

^{a,b,c} *Values bearing different supersriptes within the row differed significantly P<0.05.*

Carcass Traits: The effect of azolla levels on carcass traits of Kadaknath broilers has been shown in Table 2. The live weight (1001±21 in Az_{00}; 1026±24 in $Az_{2.5}$; 1151±9 in $Az_{5.0}$; 1078±23 in $Az_{7.5}$; 1077±28 g in $Az_{10.0}$), dressed weight (733±9 in Az_{00}; 751±22 in $Az_{2.5}$; 888±17 in $Az_{5.0}$; 800±16 in $Az_{7.5}$; 801±23 g in $Az_{10.0}$), eviscerated weight (567±15 in Az_{00}; 600±45 in $Az_{2.5}$; 831±36 in $Az_{5.0}$; 681±33 in $Az_{7.5}$; 664±41 g in $Az_{10.0}$), and Eviscerated portion (57.3±0.7 in Az_{00}; 58.6±2.3 in $Az_{2.5}$; 73.1±2.6 in $Az_{5.0}$; 63.2±1.6 in $Az_{7.5}$; 63.4±2.2 per cent in $Az_{10.0}$) were recorded higher in the group $Az_{5.0}$, whereas lower in Az_{00}. The findings indicated that the above carcass traits improved with the increased level of azolla replacement up to 5 per cent of the ration and then declined. The thigh portion (1.44±0.02 in Az_{00}; 1.42±0.02 in $Az_{2.5}$; 1.37±0.03 in $Az_{5.0}$; 1.32±0.01 in $Az_{7.5}$; 1.33±0.01% in $Az_{10.0}$) in the Kadaknath carcass was higher in Az_{00} and lower in

$Az_{10.0}$, pointing out that increasing replacement of ration with azolla caused a decrease in the thigh portion of the carcass. The heart weight (1.26±0.07 in Az_{00}; 1.36±0.08 in $Az_{2.5}$; 1.65±0.1 in $Az_{5.0}$; 1.35±0.08 in $Az_{7.5}$; 1.19±0.07 g in $Az_{10.0}$) was also higher in $Az_{5.0}$ but lower in $Az_{10.0}$, indicating that this carcass traits improved with the increased level of azolla replacement up to 5 per cent of the ration and then declined. The remaining traits of the Kadaknath broiler carcass, such as dressing (73.2±0.8-77.1±1.5%), thigh weight (14.23±0.28-15.74±0.3g), drumstick weight (14.96±0.34-16.19±0.41g), and portion (1.39±0.05-1.54±0.04%), liver weight (2.07±0.08-2.90±0.24g), gizzard weight (3.12±0.17-3.74±0.15g), and portion (0.31±0.02-0.33±0.02%) and heart portion (0.11±0.01-0.14±0.01%) were all recorded as nonsignificant (P>0.05). As a result, the findings showed that the above-mentioned carcass traits remained unaffected by the replacement of ration with different levels of azolla in Kadaknath broiler carcasses.

Table 2. Effect of Azolla levels on carcass traits of Kadaknath broilers.

Parameter	Azolla (*Azolla pinnata*) levels					
	Az_{00}	$Az_{2.5}$	$Az_{5.0}$	$Az_{7.5}$	$Az_{10.0}$	*P-Value*
Live weight (g)	$1001±21^{c}$	$1026±24^{c}$	$1151±9^{a}$	$1078±23^{b}$	$1077±28^{b}$	**
Dressed weight (g)	$733±9^{c}$	$751±22^{c}$	$888±17^{a}$	$800±16^{b}$	$801±23^{b}$	**
Dressed weight (%)	73.4±1.0	73.2±0.8	77.1±1.5	74.2±0.8	74.3±0.8	NS
Eviscerated weight (g)	$567±15^{c}$	$600±45^{c}$	$831±36^{a}$	$681±33^{b}$	$664±41^{b}$	**
Eviscerated weight (%)	$57.3±0.7^{c}$	$58.6±2.3^{c}$	$73.1±2.6^{a}$	$63.2±1.6^{b}$	$63.4±2.2^{b}$	**
Thigh weight (g)	14.39±0.17	14.56±0.44	15.74±0.3	14.23±0.28	14.34±0.42	NS
Thigh weight (%)	$1.44±0.02^{a}$	$1.42±0.02^{a}$	$1.37±0.03^{c}$	$1.32±0.01^{d}$	$1.33±0.01^{d}$	**
Drumstick weight (g)	15.41±0.2	15.14±0.51	16.19±0.41	14.96±0.34	15.53±0.39	NS
Drumstick weight (%)	1.54±0.04	1.47±0.02	1.41±0.04	1.39±0.05	1.45±0.04	NS
Liver weight (g)	2.07±0.08	2.34±0.27	2.9±0.24	2.42±0.16	2.36±0.11	NS
Liver weight (%)	0.21±0.01	0.23±0.03	0.25±0.02	0.22±0.01	0.22±0.01	NS
Gizzard weight (g)	3.12±0.17	3.37±0.16	3.74±0.15	3.5±0.18	3.31±0.18	NS
Gizzard weight (%)	0.31±0.02	0.33±0.02	0.32±0.01	0.32±0.01	0.31±0.02	NS
Heart weight (g)	$1.26±0.07^{bc}$	$1.36±0.08^{b}$	$1.65±0.1^{a}$	$1.35±0.08^{b}$	$1.19±0.07^{c}$	**
Heart weight (%)	0.13±0.01	0.13±0.01	0.14±0.01	0.13±0.01	0.11±0.01	NS

^{a,b,c} *Values bearing different supersriptes within the row differed significantly P<0.05.*

The results of this study are consistent with those of Naghshi *et al*. (2014), who found that adding 5% Azolla powder to the diet raised the percentage of carcass efficiency. The data from this study was further supported by the fact that there were no significant differences between the treatments for the liver and gizzard. According to Bhattacharya *et al*. (2018), adding 4.50% of Azolla meal to the broiler diet increased the target percentage significantly, but the other carcass attributes did not differ significantly across treatments. Furthermore, Mishra *et al*. (2016) discovered that the only differences in the cut-up sections (thigh, drumstick, neck, and back) and carcass quality criteria (dressing percentage and ready to cook yield) were in the wings and liver weight percentage. The giblet percent was higher

in the 3% Azolla meal fed group compared to the control and 6% Azolla fed group, according to *Lakshmi et al. (2019)* and Varadharajan *et al*. (2019). According to Thavasi *et al*. (2020), birds fed 0, 3, 6, 9, and 12% Azolla meal had average dressing percentages of 64.11, 66.14, 69.07, 67.12, and 68.62. Azolla meal feeding resulted in numerically higher dressing percentages at the 6% and 9% levels, respectively, demonstrating the advantageous effects of herbals like Azolla meal feeding on dressing percentage.

Conclusion

It can be concluded on the basis of present investigation that the broiler ration may be replaced at a 5 per cent level with sun-dried azolla powder to increase the productivity of the Kadaknath broilers.

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Antibiotic and antifungal characteristics of moringa (*Moringa oleifera*)

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Abstract

To summarize the antibacterial, antifungal, and wound-healing properties of moringa (Moringa oleifera), a review of the literature has been conducted. It has been shown that Moringa oleifera *is a rich source of antioxidants, phenolic compounds, and a variety of other biochemicals e.g. tannins, saponins, flavonoids, and steroids. In the plant, these organic substances have potent antimicrobial, antibacterial, and antifungal properties. The features of* Moringa oleifera*, present in its leaves, flowers, pod, bark, and roots, developed wound-healing properties in a variety of forms, including fresh, powdered, and extracts.*

Keywords: antibacterial, antifungal, antimicrobial, moringa, wound healing.

Introduction

Many of the antibacterials that are currently in use have side effects that include toxicity, hypersensitivity, immunosuppression, and tissue residues that could be dangerous for the public's health. Furthermore, poor farmers cannot afford the more expensive, newer broad-spectrum antibiotics. Due to these drawbacks, the therapeutic efficacy of the antibacterials that are now on the market is compromised, making the search for substitute treatments for bacterial illnesses necessary. The development of contemporary medications from traditional medicinal plants should be prioritized for the treatment of a variety of human and animal diseases, as the global landscape is currently shifting toward the use of non-toxic and environmentally friendly products.

A significant component of traditional medical systems that have endured in developing nations are medicinal plants.

Over 500,000 natural products are produced by the plant kingdom, with between 40 and 80 thousand produced by each species of plant (Bhatt, 1995). There has been a lot of attention lately to the application of plant-based traditional medicine (Han et al., 2002). Regarding resources derived from plants, both national and indigenous rights exist. There has been a rise in fundamental scientific research on medicinal plants and traditional medical practices. According to estimates, just 1–10% of the vast diversity of 250,000–500,000 plant species on Earth have had their medicinal qualities investigated pharmacologically and chemically (Farnsworth, 1991; Verpoorte, 2000). It has been suggested recently that *Moringa oleifera* has a new benefit: the leaves appear to contain something that promotes plant development and raises crop yields.

One such plant with numerous purported therapeutic benefits is *Moringa oleifera*. According to Sharma et al. (2022a), different Indian moringa (*Moringa oleifera*) components have phenolic, antioxidant, and free radical-scavenging qualities. Seasonal variations in *Moringa oleifera* 's antioxidant properties result in higher levels during the winter and lower levels during the summer (Sharma et al 2022b). Indigenous medical systems use various components of this plant, including the leaves, stem bark, root bark, flowers, fruits, and seeds, to cure a range of human diseases (Chopra et al., 1956; Nadkarni, 1976). Although *Moringa oleifera* root bark is said to have a variety of medicinal uses, little research has been done on its antibacterial activity in recent years despite the fact that the plant's leaves and seeds have been the subject of extensive scientific investigation. Consequently, it was thought worthwhile to look into *Moringa oleifera* root bark's antibacterial properties. In Eritrea, the feeding value of *Moringa oleifera* to rabbits has been evaluated (Kishore and Goitom, 2021a). Research has been done on the ethogram of rabbits given *Moringa oleifera* pod meal (Kishore and Goitom, 2022). Research has also examined the impact of temperature on the general and excretory behavior of White New Zealand rabbits raised on *Moringa oleifera* pod meal (Kishore and Goitom, 2021b). Bark has been utilized to treat scurvy, dental caries/toothache, external sores/ulcer, anti-tumor, snakebite, scorpion bite, headache, digestive issues, and antinutritional aspects (Fahey, 2005).

Antimicrobial characteristics of *Moringa oleifera*

The therapeutic efficacy of *Moringa oleifera* Lam is highly substantial. Many plant parts, including the leaves, roots, seeds, bark, fruit, flowers, and immature pods, have the ability to stimulate the heart and circulatory system, have antibacterial and antifungal properties, and are used in the traditional medical system to treat a variety of illnesses (Dhimmar et al., 2015). The chemical N-benzylethyl thioformate, an aglycone of deoxyniazimincin, is present in *Moringa oleifera* ethanolic root extract and is responsible for the plant's antibacterial activity against a wide range of bacteria and fungi (Upadhyay et al., 2015). Urinary tract infections caused by both Gram-positive and Gram-negative bacteria, including *Staphylococcus aureus, Escherichia coli*, and *Staphylococcus saprophyticus*, may be inhibited by methanolic leaf extract from *Moringa oleifera* (Maurya and Singh, 2014). In vitro tests were conducted to examine the antibacterial properties of *Moringa oleifera* leaves, roots, bark, and seeds against human pathogenic bacteria, yeast, dermatophytes, and helminthes. It was shown using the

disk-diffusion method that *Pseudomonas aeruginosa* and *Staphylococcus aureus* cannot grow when fresh leaf juice and seed aqueous extract are present, and that this activity is inhibited by extraction temperatures higher than 56°C (Caceres et al., 1991). *Moringa oleifera*'s antimicrobial components have been confirmed to have inhibitory efficacy against a variety of bacteria. *Scenedesmus obliquus* (green algae), *E. coli* ATCC 13706, *P. aeruginosa* ATCC10145, *S. aureus* NAMRU 3 25923, *Bacillus stearothermophilus* (bacterial strains), Herpes Simplex virus type 1 (HSV 1), and Polio virus type 1 (sabin vaccine) were used in another study involving aqueous methanolic extract and fixed oil against microorganisms. The antibacterial action of *Moringa oleifera* seeds is thought to be attributed to their active constituents, 4-(alpha-L-rhamanosyloxy) benzyl isothiocyanates (Padla et al., 2012). Alkaloids, flavonoids, and steroids found in *Moringa oleifera* fruit have an inhibitory effect on *Candida albicans* culture by either denaturing the protein or preventing spore germination due to the steroid ring they contain (Moodley et al., 2018). Studies have shown that the leaves and flowers of *Moringa oleifera* have antihelmintic activity, which means that they can help control parasitic worms (Bhattacharya et al., 1982). Furthermore, ethanolic extracts from *Moringa oleifera* leaves have been shown to suppress the Indian earthworm *Pheritima posthuma* (Rastogi et al., 2009).

Based on the analysis of the aforementioned studies, it can be concluded that different *Moringa oleifera* organs contained particular biochemicals e.g., tannins, saponins, flavonoids, steroids, and phenolic substances etc. that enabled the plant's antibacterial properties.

Antibacterial characteristics of *Moringa oleifera*

The antibacterial properties of *Moringa oleifera* seed extracts, both aqueous and ethanolic, were tested against Salmonella enteritidis, vibrio cholerea, *Staphylococcus aureus*, and *E. coli* (isolated from the organism and the aquatic environment) in volumes 50, 100, 150, and 200 µl. The concentrations of 1.5 and 1.10 units were used. Aqueous and ethanolic extracts of *Moringa oleifera* showed antibacterial efficacy (inhibition halo> 13mm) against *S. aureus, V. cholera, and E. coli* isolated from the white leg shrimp, *Litopenaeous vannmaei*. *E. Coli* that was obtained from *Oreochrom isniloticus* and tilapia fish showed sensitivity to *Moringa oleifera* 's ethanolic extract. According to Kone et al. (2004), bacteria are the microorganisms that cause opportunistic diseases in the highest-ranking order. Nowadays, bacterial infections are treated with a plethora of antibacterial medicines. However, many virulently pathogenic bacterial species developed drug resistance as a result of the widespread and careless use of antibacterial medicines (Berkowitz, 1995). Because of its many applications and well-known bactericidal potential, the *Moringa oleifera* plant has been the subject of extensive research (Suarez et al., 2003; Ghebremichael et al., 2005). Studies on the antibacterial properties of *Moringa oleifera* plants have been conducted for 40 years; however, since 2012, only nine years have been devoted to the goal of combating antibiotic resistance. Strong proof is the use of Multi-Drug Resistance (MDR) bacteria as test organisms. Both in vitro and in vivo antibacterial testing of *Moringa oleifera* plants against MDR bacteria has been done. Plants known as *Moringa oleifera* have the ability to resist harmful bacterial infections (Novitarini et al., 2022). According to

Mishra et al. (2011), the juice of *Moringa oleifera* leaves has the ability to combat harmful microorganisms that affect humans. The essential oil portion of the plant material contained in the distillate fraction may be the cause of the stem distillate of *Moringa oleifera* 's antibacterial properties (Ravindra et al., 2019). The distillate of *Moringa oleifera* showed a significant decrease in the growth of test microorganisms, indicating an antibacterial action. *E. coli* showed the highest level of inhibition among the studied microorganisms, followed by *S. aureus*, *K. pneumoniae*, *P. aeruginosa*, and *B. subtilis*. Potent suppressive effects of the seed kernel extract of *Moringa oleifera* were noted for Bacillus cereus, *Staphylococcus aureus*, *Aspergillus species*, and *Mucor species*. Nevertheless, its efficacy against *E. coli* and *P. aeruginosa* was reduced. This suggested that *Moringa oleifera* seed kernel extract could be used to treat infections caused by these species, with the exception of *E. coli* and *P. aeruginosa* (Dinesha et al., 2018). Only an apolar extract made from *Moringa oleifera* seeds exhibited antibacterial efficacy against Gram-positive bacteria, according to a recent study (Anzano et al. 2022). Using the disk-diffusion method, Caceres et al. (1992) investigated the antibacterial properties of *Moringa oleifera* leaves, roots, bark, and seeds against dermatophytes, helminths, bacteria, and yeast. *Pseudomonas aeruginosa* and *Staphylococcus aureus* are inhibited from growing by the fresh leaf juice and aqueous extracts from seeds. They deduced that no action was seen against *Candida albicans*, Gram-positive, Gram-negative, or other harmful microorganisms. Mehta et al. (2003) reported that the stem bark juice had antibacterial properties against *S. aureus*. Three fractions of *Moringa oleifera* leaf extract were tested for their antimicrobial activity against *E. Coli*, *Klebsiella aerogenes*, *K. pneumoniae*, *S. aureus*, and *Basillus subtilis* by Dahot (1998). It was found that all three fractions exhibited potent inhibitory activity against *E. Coli*, *S. aureus*, and *B. subtilis*. However, fraction 2 demonstrated a considerable zone of inhibition against *Aspergillus niger*, and a definite zone of inhibition was observed against *K. aerogenes*. Similar claims were made by Amer et al. (2008), Renitta et al. (2009), Peixoto et al. (2011), and Mbikay (2012) on the potential use of ethanol and aqueous *Moringa oleifera* leaf extract as a therapy for specific bacterial infections. Water treated with *Moringa oleifera* powder can eliminate up to 90–99% of the germs present because they are associated to solid particles (Schwarz, 2000; Oloduro and Aderiye, 2007; Amagloh and Benang, 2009; Bukar et al., 2010). Similar to this, Shekhar et al. (2000) investigated the antibacterial activity of crude ethanol extract of *Moringa oleifera* seed against *Salmonella typhii, E. coli, Vibrio cholera, Shigella dysentriae*, and *Pseudomonas aeruginosa* in drinking water. They concluded that the extracts had an effect on E. coli. The antibacterial activity of *Moringa oleifera* seed extract was also evaluated by Arama et al. (2011) against *E. coli* (ATCC 25922), *S. typhii*, and *V. cholerae*. The results showed that *V. cholerae* was the bacteria species most resistant to *Moringa oleifera* extract, compared to *E. coli* and *S. typhii*. Rahman et al. (2009) examined the antibacterial activity of leaf extracts from *Moringa oleifera* against six gram-positive bacteria (*Staphylococcus aureus*, *Bacillus cereus*, *Streptococcus-B-haemolytica*, *Bacillus subtilis*, *Sarcina lutea*, and *Bacillus megaterium*) and four gram-negative bacteria (*Shigella shinga*, *Pseudomonas*

aeruginosa, *Shigella sonnei*, and *Pseudomonas spp*.) and six gram-positive bacteria (*Staphylococcus aureus, Bacillus cereus, Streptococcus-B-haemolytica*, *Bacillus megaterium*). The results showed that leaf extracts had an inhibitory effect on all tested bacteria, with the exception of *S. aureus* and *S. haemolytica*. Doughari et al. (2007); Nantachit (2006) and Prashith et al. (2010) noted that *Moringa oleifera* had comparable antibacterial efficacy against certain microorganisms. A recent study by Saadabi and Abu Zaid (2011) discovered that aqueous extracts of *Moringa oleifera* had dose-dependent inhibitory effects against many pathogenic microorganisms, such as *Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Additionally, it was discovered that extracts from *Moringa oleifera* were inhibitory to B. subtilis and Mycobacterium phlei (Eilert et al., 1981). Different levels of antimicrobial activity were noted, ranging from *P. aeruginosa* resistance to *B. stearothermophilus* sensitivity (Ali et al., 2004). Pseudocides and *B. subtilis* were the most sensitive strains of bacteria, and cations (Na+, K+, Mg2+, and Ca2+) affected their activity, according to a study comparing the relative antimicrobial activity of seed extracts against bacteria (*Pasturella multocida, E. coli, B. subtilis, and S. aureus*) (Jabeen et al., 2008). Pterygospermin, which was first identified in Moringa pterygosperma, is present in *Moringa oleifera* and possesses potent antibacterial properties (Rao et al., 1946). According to Prashit Kekuda et al. (2010), there was a greater suppression of *E. coli, S. aureus, Klebsiella pneumoniae*, *P. aeruginosa*, and *B. subtilis* in a comparative analysis of the antibacterial activity of *Moringa oleifera* steam distillate. One study using an ethanolic extract of leaves, seeds, and flowers showed the antibacterial activity against *E. coli, K. pneumoniae, Enterobacter species, Proteus mirabilis, P. aeruginosa, Salmonella typhi A, S. aureus, Streptococcus*, and *Candida albicans*, in contrast to resistance against *P. aeruginosa* and *Candida albicans* for *Moringa oleifera* in other studies (Nepolean et al., 2009). There have been reports of antibacterial activity for a number of other specific components of *Moringa oleifera*, such as 4-(4'-O-acetyl-a-L-rhamnopyranosyloxy) benzyl isothiocyanate, 4-(a-L-rhamnopyranosyloxy) benzyl isothiocyanate, niazimicin, benzyl isothiocyanate, and 4-(a-L-rhamnopyranosyloxy) benzyl glucosinolate (Fahey). The root contains other bioactive substances that are effective against a variety of germs, including spirochin and anthonine. Strong inhibitory action of anthonine is seen against *Vibrio cholerae* (Nwosu and Okafor, 1995). Against four additional pathogenic gram-positive and gram-negative bacteria as well as *Candida albicans*, no activity was shown. No activity against six pathogenic dermatophytes was shown using a dilution approach (Caceres et al., 1991). Numerous research have demonstrated *Moringa oleifera* 's antibacterial properties. Bukar et al. (2010) assessed the bactericidal activity of *Moringa oleifera* leaf and seed chloroform and ethanol extracts using the Disc agar diffusion technique. Tests were conducted on the antibacterial activities of *Moringa oleifera* against six Gram-negative bacteria (*E. coli, Enterobacter aerogenes, Pseudomonas aeruginosa, Salmonella typhi, Salmonella typhimurium*, and *Shigella spp*.) and one Gram-positive bacteria (*Staphylococcus aureus*). Leaf ethanol (MLE) extracts from *Moringa oleifera* shown efficacy against four bacterial isolates. At all the quantities

tested, *Shigella species, S. typhi*, and *S. typhimurium* were not sensitive, but Enterobacter species, *S. aureus, P. aeruginosa*, and *E. coli* were. The leaf chloroform (MLC) of *Moringa oleifera* shown efficacy against *S. typhi, S. typhimurium*, and *E. coli*. Similarly, three bacterial isolates (*S. aureus*, *E. coli*, and *S. typhi*) were susceptible to the effects of *Moringa oleifera* seed ethanol (MSE) extract. *P. aeruginosa*, *S. typhimurium*, *Shigella spp*., and *Enterobacter spp*. were insensitive to all tested doses. Two bacterial isolates (*S. typhimurium* and *E. coli*) were successfully combatted by *Moringa oleifera* seed chloroform (MSC) extract. *P. aeruginosa, S. typhi, Shigella spp., Enterobacter spp.,* and *S. aureus* were insensitive to all tested doses. Lar et al. (2011) discovered the antibacterial efficacy of ethanol and aqueous extracts of dried *Moringa oleifera* seeds using three gram negative organisms: *E. coli, Shigella flexneri*, and *Salmonella typhi*. They did this by using the agar well diffusion method. At the several quantities tested, the water extract had little effect on the test organisms; however, the ethanolic seed extract showed significant antibacterial action, with *Shigella flexneri* and *E. coli* showing susceptibility. Both extracts did not reveal any susceptibility to *Salmonella typhi*. The studies conducted by Bijal and Bhumika (2015) verified that distinct inhibition patterns were seen in the ethanol, methanol, petroleum ether, and aqueous extracts of *Moringa oleifera* leaves. The outcome shows that *Moringa oleifera* 's leaf, flower, pulp, and seed solvent extracts were effective against *S. aureus* and *E. coli*. According to Dzotam et al. (2016), leaf extracts of *Moringa oleifera* may be used either alone or in conjunction with other antibiotics to treat a variety of infectious disorders. Furthermore, Khanitta and Angelika (2015) used the Bauer-Kirby diffusion technique to ascertain the antibacterial activities of three distinct extracts:

i) a cold water extract of *Moringa oleifera* seed powder;

ii) a cold water extract of *Moringa oleifera* residue following oil extraction by Soxhlet method; and

iii) a cold water extract of *Moringa oleifera* seed oil obtained by Soxhlet method (disk method).

All investigated isolates (*Staphylococcus aureus, Bacillus subtilis, Salmonella typhimurium*, *Enterobactor aerogenes*, and *Pseudomonas aerogonosa*) are effectively inhibited by *Moringa oleifera* seed oil. Similarly, extracts from the seeds and residue of *Moringa oleifera* are effective against every bacterial isolate mentioned above, with the exception of *Staphylococcus aureus*. The investigations conducted by Patel and Mohan (2018) verified that distinct *Moringa oleifera* tissue extracts exhibited varying patterns of inhibition against several bacterial strains. *Salmonella typhi, Salmonella paratyphi, Pseudomonas aeruginosa, Salmonella coli, Escherichia coli, Bacillus cereus, Bacillus subtilis, Enterococcus faecalis, Micrococcus luteus, Staphylococcus aureus, Staphylococcus epidermidis*, and *Salmonella typhi* are the organisms that are being examined. Bichi and Shehu (2018) used the Agar well diffusion method in another study. The *Moringa oleifera* seed oil demonstrated a discernible antibacterial effect on E. coli when extracted in hexane. The average zones of inhibition for the 100%, 75%, 50%, and 25% of the seed oil were 17.7 mm, 14.3 mm, 11.3 mm, and 9.0 mm, respectively. The distillate of *Moringa*

oleifera showed a significant decrease in the growth of test microorganisms, indicating an antibacterial action. According to Biswas et al. (2012), among the bacteria that were examined, *E. coli* showed the greatest suppression. *S. aureus, K. pneumoniae, P. aeruginosa,* and *B. subtilis* also showed significant inhibition. According to Kekuda et al. (2010), the essential oil portion of the plant material included in the distillate fraction may be the cause of the steam distillate of *Moringa oleifera* 's antibacterial activity. According to Ayyanar et al. (2023), ethy-l-acetate and methanolic extracts shown higher levels of inhibition against the investigated bacterial strains, including E. coli (24.0 ± 0.1 mm) and *Pseudomonas aeruginosa* (25.1 ± 0.3 mm). To increase antibacterial qualities, *Moringa oleifera* Ag-NPs and their crude aqueous extract can be used (Ahmed et al., 2023).

After reviewing the previous research, it can be said that because different varieties of *Moringa oleifera* include a variety of natural chemicals e.g. tannins, saponins, flavonoids, steroids, and phenolic substances etc., they have potent antibacterial properties.

Antifungal characteristics of *Moringa oleifera*

Numerous investigations have demonstrated the antifungal properties of various crude extracts from various *Moringa oleifera* tissues against fungus. The antifungal activity of ethanol and chloroform extracts of *Moringa oleifera* leaves and seeds was assessed by Bukar et al. (2010). The study's findings demonstrated that MSC completely prevented the development of Rhizopus and *Mucor spp*. at a concentration of 1000 µg/ml, while MSE only partially prevented the growth of Rhizopus and Mucor spp. at a dose of 1000 µg/ml. At 1000 µg/ml, MLC inhibited the growth of Rhizopus and *Mucor spp*. by 25%, while MLE inhibited the growth of Rhizopus and *Mucor spp*. by 100% and 50%, respectively, at the same concentration. Based on this investigation, it was found that MSC exhibited the highest level of antifungal activity against the test fungus, totally inhibiting the development of both Rhizopus and *Mucor species* at 1000µg/ml. The chemical N-benzylethyl thioformate, an aglycone of deoxyniazimincin, is present in *Moringa oleifera* ethanolic root extract and is responsible for the plant's antifungal action against a wide range of bacteria and fungi (Upadhyay et al., 2015). The antifungal strains Aspergillus flavus, *Aspergillus terreus, Aspergillus niger, Aspergillus oryzae, Fusarium solani, Penicillium sclerotigenum, Cladosporium cladosporioides, Trichophyton mentagrophytes, Penicillium species,* and *Pullarium species* have all been shown to be inhibited by extracts from the leaves, seeds, and stems of *Moringa oleifera* (Upadhyay et al., 2015). According to Ahmadua et al. (2020), the methanolic leaf extract exhibits about 99% suppression against the necrotrophic plant fungus *Botrytis cinerea*. The essential oil portion of the plant material contained in the distillate fraction may be the cause of the stem distillate of *Moringa oleifera* 's antifungal properties (Ravindra et al., 2019). A further sign of fungal inhibition was a smaller colony diameter on distillate-poisoned plates when compared to control plates. Using the broth dilution and agar plate procedures, Nwosu and Okafor (1995), Nikkon et al. (2003), Chen et al. (2007), Jamil et al. (2008), and Prashith et al. (2010) reported the antifungal efficacy of *Moringa oleifera* leaf extract against seven

pathogenic fungi. It was discovered that *Moringa oleifera* leaf extract was useful in inhibiting the growth of *Basidiobolus haptosporus* and *Basidiobolus ranarums* fungi (Nwosu and Okafor, 1995). In addition, *Moringa oleifera* has the ability to inhibit fungi (Chuang et al., 2007). According to a study evaluating the relative antibacterial activity of seed extracts against two fungi, *Fusarium solani* and *Rhizopus solani*, these strains were the most susceptible, and cations, such as Na+, K+, Mg2+, and Ca2+, affected their activity (Jabeen et al., 2008). Pterygospermin, which was first discovered in *Moringa pterygosperma*, is present in *Moringa oleifera* and possesses potent fungicidal properties (Rao et al., 1946). According to Prashit Kekuda et al. (2010), *Aspergillus niger* exhibited the strongest inhibition, followed by *Aspergillus oryzae*, *Aspergillus terreus*, and *Aspergillus nidulans*. Pinal et al. (2014) demonstrated the antifungal effectiveness of *Moringa oleifera* leaf extracts against *Saccharomyces cerevisiae*, *Candida albicans*, and *Candida tropicalis* using the Agar well diffusion method. While no action was seen against *Candida albicans*, the ethanol and aqueous leaf extract results demonstrated activity against *Saccharomyces cerevisiae* and *Candida tropicalis*. When applied to *Saccharomyces cerevisiae*, water and ethanol extract of *Moringa oleifera* exhibited the biggest zone of inhibition. Using the agar well diffusion method, researchers examined the antifungal activity of aqueous and ethanol extracts of *Moringa oleifera* Lam. leaf against a range of clinical fungal pathogens, including *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus fumigatus*, and *Cryptococcus neoformans* (Isitua et al., 2016). The outcome demonstrated that all fungal strains were susceptible to the ethanol and water extracts in the crude extracts of *Moringa oleifera*. In a recent study, Aondo et al. (2018) discovered that the crude extracts of *Moringa oleifera* (Bark seed and leaf) reduced the growth of *Aspergillus flavus mycelia*. *Certain saprophytic* fungi cannot contaminate culture media due to *Moringa oleifera* 's antifungal properties. The results indicated that the fungi could be effectively inhibited by ethyl acetate, methanolic, ethanolic, and aqueous extract of *Moringa oleifera* leaves, seeds, and bark. The study conducted by Patel and Mohan (2018) revealed that distinct tissue extracts of *Moringa oleifera* exhibited varying patterns of inhibition against distinct strains of fungi. *Aspergillus niger, Aspergillus paracitic, Candida albicans, Aspergillus flavus, Trichoderma harzanium, Alternata burnsi*, and *Fusarium oxysporum* are among the tested fungal isolates. Reduced colony width in distillate-poisoned plates as compared to control plates was another indication of fungal inhibition (Biswas et al., 2012). *A. niger* showed the greatest inhibition, followed by *A. oryzae*, *A. terreus*, and *A. nidulans*. The essential oil fraction of the plant material contained in the distillate fraction may be responsible for the steam distillate of *Moringa oleifera* 's antifungal properties (Kekuda et al., 2010). the existence of tannins, saponins, flavonoids, steroids, and phenolic substances. Against *C. kruzei*, the investigated extracts showed varying degrees of antifungal activity. With a minimal inhibitory concentration of 10 mg/ml, the leaf extract demonstrated efficacy against C. kruzei (Al-Khalasi et al., 2024).

Based on the analysis of the results mentioned above, it can be concluded that *Moringa oleifera* has excellent antifungal properties due to the presence of a variety of natural chemicals like tannins, saponins,

flavonoids, steroids, and phenolic substances etc.

Wound healing characteristics of *Moringa oleifera*

Ethyl acetate and a 300 mg/kg dosage of *Moringa oleifera* leaf water extract were shown to have a substantial impact on wound healing following incision or excision (Mishra et al., 2011). According to research, dried pulp extracts, leaves, and seeds have demonstrated effective improvement of wound closure, granuloma rupture strength, and reduction of skin rupture strength in the scar area in preclinical experiments (Muhammad et al., 2016). By enhancing the downregulation of inflammatory markers and raising the level of vascular endothelial growth factor in the wounded tissue, leaf extracts have demonstrated encouraging effects in diabetic rats (Bhattacharya et al., 2018). By lowering the levels of several inflammatory indicators, compounds found in aqueous extract have had a significant impact on diabetic foot ulcers (Muhammad et al., 2016). The most potent standardized extract was chosen by the researcher through an in vitro experiment, and it was subsequently made into a film to aid in wound healing. According to the findings, among the various extracts, the aqueous extract exhibited the highest levels of cell proliferation and migration (Awodele et al., 2012). When compared to oral or topical use of other extracts, the most popular intervention for wound healing was determined to be the aqueous extracts of *Moringa oleifera* leaves. In the meantime, the fastest excision-induced wound healing activity was demonstrated by the n-hexane extract of *Moringa oleifera* seeds (Shafie et al., 2022). Using in vivo models, Ashames et al. (2024) evaluated the effectiveness of amniotic fluid and *Moringa oleifera* - loaded nanoclay films for wound healing. AMF-Me.mo-loaded nanofilms' antimicrobial activity helped to clean the wound site, putting them in a position to be a viable option for rabbit burn wound healing. Abdullah et al. (2022) used an infected excision wound model in rats to study the wound-healing properties of *Moringa oleifera* leaf extract. Methicillin-resistant Staphylococcus aureus (MRSA) or Pseudomonas aeruginosa were used to cause infection. In addition to its antibacterial properties, *Moringa oleifera* demonstrated a considerable improvement in wound contraction, a shorter time to epithelization, higher activity of antioxidant enzymes, and a decrease in capillary density. In contrast to MRSA, the extract had less of an impact on wounds infected with P. aeruginosa. *Moringa oleifera* boosted the expression of the VEGF and TGF-β1 genes.

Conclusion

It has been shown that *Moringa oleifera* is a rich source of antioxidants, phenolic compounds, and a variety of other biochemicals e.g. tannins, saponins, flavonoids, and steroids. In the plant, these organic substances have potent antimicrobial, antibacterial, and antifungal properties. The features of *Moringa oleifera*, present in its leaves, flowers, pod, bark, and roots, developed wound-healing properties in a variety of forms, including fresh, powdered, and extracts.

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Support of spirituality and traditional culture to achieve sustainable development goals

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Abstract

'Sustainable Development Goals' is the Mission set by the United Nations to reduce poverty and provide basic needs to ensure food security and better quality of life. However with a wide variation in the socio-economic status among different sections of the societies, people with better knowledge, resources and social status are able to dominate others, constantly widening the economic disparity. The exploitation of the poor by rich has been going on ever since the origin of the human races. Knowing the attitude to crave for more, the spiritual scholars of different religions have developed their moral code of conduct, which is expected to be followed to maintain harmony and happiness within the community. If some of the basic principles such as selfless service, control on greed, non-violence, honesty and compassion, etc. are practiced in our daily life, the earth would have plenty of food and other resources to meet the needs of all, and the weaker sections of the society need not struggle to earn their livelihood. Similarly, if all the persons engaged in implementing the sustainable development programme take their jobs as their moral obligation, then the chances of success of the programme will be certain. Hence, spiritual orientation should be an integral part of the Sustainable Human Development.

Keywords: Sustainable Development, Manava Dharma, Asthanga Yoga, Spirituality and Sustainable development

Uniqueness of Human Species

Human beings are very special living creatures in the world, different from all other animals because of their ability to think, analyse and act as per their will. Our uniqueness is our ability to think (Johnson, 2002), remember past experiences and develop our intellect (Buddhi), which make us alert in responding suitably on different occasions for our safety and security. Human species is the highest and the most

advanced form of genetic evolution in the world. It has taken over six million years (Sharma, 2007) of genetic modification after the birth of the first mammal to generate the human species. It has taken over 5 - 6 million years for the development of human beings from the monkey. The first human race originated only about two lakh years ago. This indicates the most superior status of human species in the universe. This finding confirms the ancient Hindu spiritual scriptures that the human is the highest and most advanced form of living creature in the animal kingdom. The spiritual scriptures also mention that the soul present in human beings would have taken several births and rebirths as different animal species and the souls performing good deeds (Karma) get an opportunity to take birth as human beings.

The human population which originally grew up in Africa for millenniums, gradually migrated in groups to different parts of the world and evolved their cultures and languages during the next 150,000 years. By about 10,000 BC, the human population had spread all over the world, settled in fertile river valleys and started agriculture and animal husbandry for their livelihood. They started feeling the need for recognising the role of different people in the community, respecting each other for living in harmony. Around 3000 BC, known as the Bronze Age, the communities settled in the Indus valley of the Indian subcontinent, as well as in Egypt and Iraq, were considered as three early world civilisations. During the same period, around 3500 BC, the Minoan civilization was established in Europe, which was the first civilization in the world. The Indus Valley Civilisation, which was developed between 2600 BC and 1900 BC had developed the art of cultivating land for plenty of food production. The community developed *Sanskrit script for documentation, while the language for communication was developed long before. People started asking many questions about human origin, source of livelihood, presence of God, the way to live, etc. They recognised five elements of nature - water, earth, air, fire and space (Akash) (Muralivallabhan, 2022) as the basis of all living and non-living creatures and started respecting them and worshipping these resources as God. This was the beginning of the human civilisation.*

This was the emergence of the Vedic culture, when many spiritual scholars meditated deeply, sacrificing their family comforts and turned into sages (*Rishis*). They documented the knowledge they imbibed during deep meditation and this tradition continued for many centuries. Later, their recitations were documented and known as the *four Vedas namely,* Rigveda, Yajurveda, Samaveda and Atharvaveda. In each Veda, certain parts were dealt with rituals and prayers (Karma-Kanda), while some other sections contained the philosophy of God, known as Brahman and Self-consciousness (Jnana-Kanda). The teachings of Vedas were summarised in Vedanta through three important documents, namely Upanishads, Bhagavad Gita and Brahma-sutras. Hindus consider the Vedas as the impersonal, authorless revelations with specific sacred sounds, heard by ancient sages after intense meditation. These Vedas narrate the concept of Hinduism and the logic behind the suggested actions. The teachings of the Bhagavad Gita, Mahabharata and Ramayana also convey the essence of Vedas and Upanishads, in a simple language to help common people to understand their moral and righteous duties and to tide over their emotional crisis. These documents were considered as the

model code of conduct or the rule-book for ideal way of living. These scriptures also serve as a guide to think about the purpose of human existence and to set their goal in life, which is known as *Purushartha* (Aims of human life).

Purpose of living

Unlike other animals, human beings are born with a unique mental faculty to choose and act against natural laws. They generally develop a tendency to possess more, craving for comforts. In the process of acquiring more resources and power, they do not hesitate to disturb the life of other fellow beings as well as of animals and plants living around them. Therefore, the sages have introduced two sets of rules, such as carrying out the moral duties and to pursue the ultimate goal of self-realisation, curbing their natural instincts of grabbing and craving for pleasure. Accordingly, the human endeavours should focus on achieving Dharma, *Artha*, *Kama* and *Moksha* (Mishra, 2013). Dharma is the moral obligation to sincerely serve for the welfare of others. Artha is to generate wealth through honest means to meet the materialistic and social requirements. Kama is to fulfil the needs and acquire social recognition for pleasure. Moksha is the real and ultimate human goal to detach from the materialistic and emotional possessions to unite with God or the super-soul for real bliss (happiness and peace), which can be achieved through right knowledge.

Eternal laws for living: the rules for human living

These eternal laws or the universal code of conduct is known as *Sanatana Dharma*. It was evolved for all the human beings to develop high standards of living in happiness. Sanatana Dharma suggests that the supreme reality is Brahman (Saha, 2021), who is formless and invisible, but can come in many forms and names on different occasions (reincarnation). The soul or *Atman* is the essential element in each person, which is infinite, indestructible, indivisible and eternal. It enters the body before birth and leaves the body at the time of death (transmigration). Sanatana Dharma believes in the Law of Karma, which suggests that any action committed by someone to hurt others will come back to affect that person in the future life, if not during this life. The same principle is applicable for good deeds as well. The main goal of life is to achieve liberation from the painful cycle of birth and death, which can be achieved by giving up attachment and jealousy. The best way to gain freedom from miseries and painful sufferings is to relinquish personal desires. Humanity should be the core principle of life with non-violence, equality and selfless service. Different people with different religious faith will find the same eternal truth. Hence, one should have tolerance, non-aggression and compassion for others, including plants and animals.

The communities living in Indus valley, following Sanatana Dharma were named as Hindus. Later, several other religions were established by spiritual leaders in different regions. The Jewish sacred text ‘Hebrew Bible’ has prescribed the laws of conduct known as the Ten Commandments that directs their followers to maintain good behaviour. The other religions such as Christianity, Islam, Jainism and Buddhism have a common belief that God is supreme, omnipresent, creator and maintainer of the universe. People of different religions have called Him by different names. All these religions have developed their code of conduct to maintain high moral values.

These moral values set by different religions are like the rules for ideal living. Before playing any game, the players are expected to understand the rules of the game thoroughly. This will help them to practice properly and play skilfully to win the game. Without the rules, it is impossible to play any game and arrive at any conclusion. Similarly, the Government and business establishments have their standard policies to function effectively with transparency. Likewise, without the moral code of conduct, it is impossible for us to live in harmony with others and the nature.

Ashtanga yoga for self-realisation

Over 5000 years ago, a supreme Yoga scholar, Sage Patanjali prescribed an eight-fold path for reaching the ultimate goal of self-realisation, known as the Ashtanga Yoga (Bhasin. 2008). The following eight components include the moral code of conduct (*Yama*), personal discipline (*Niyama*), physical and breathing exercises, which are basic necessities for human well-being.

- Yama: Adoption of moral codes such as Non-violence (Ahimsa), Truthfulness (Satya), Non-stealing (Asteya), Celibacy (Brahmacharya) and Non-possessiveness (Aparigah).
- Niyama: Maintaining personal disciplines such as Purity (Shoucha), Contentment (Santosh), Endurance (Tapa), Self-study (Swadhyaya) and Dedication (Eshwar Pranidhan).
- Asana: Taking a stable and comfortable Yoga position.
- Pranayama: Start breathing with concentration on breath.
- Pratyahara: Withdrawal of the senses to increase the power of the mind.
- Dharana: Concentration of mind on one object.
- Dhyan: Meditation, by focusing on one point and concentrating on it.
- Samadhi: State of supreme bliss and joy, while merging the self with Brahman.

Thus the spiritual scriptures insist on regular control of human behaviour for progress, both in personal and public life.

Caution about blind rituals

To imbibe high moral values and to promote good deeds, the Hindu traditions based on Sanatana Dharma have introduced several rituals from the conception of a child by the parents until death, aimed to inculcate good values, known as Samskaras. However some of these rituals are outdated and misconceived. Therefore, while following the old rituals prescribed in the scriptures, it is necessary to be cautious and rational, because there have been rampant exploitation of innocent people in the name of rituals and religion. Most of the rituals were initially introduced to create faith and devotion among common people (McGuire, 2008). However, these religious practices became a source of blind faith and exploitation by the priests and other vested interests in the society, which were absolutely unethical and unreasonable. Such exploitations were resisted from time to time. This has also been the reason for revolt and birth of new religions and faith. For instance, Raja Ram Mohan Roy witnessed various socio-religious evils such as the Sati system, polygamy, child marriage, persecution of widows, caste distinction and meaningless Hindu

ceremonies including human sacrifice, lavish expenditure on food, alcohol and prostitution under Tantrism, which were practiced as Hindu customs. In protest against these practices, he established the Brahmo Samaj in 1828, which propagated the worship of one Supreme God, based on the tenets of the Upanishads and the Bhagavad Gita. In 1875, Swami Dayanand Saraswati established the Arya Samaj, upholding the validity of the Vedas, the doctrines of Karma and the importance of *Samskaras*, while opposing the worship of images, animal sacrifice, and rejecting castes and untouchability, child marriage, pilgrimages, offerings to priests and temples, etc. Mahatma Gandhi and Bhimrao Ambedkar fought against untouchability. The time has come to understand the principles of our religion and practice them, while discarding many outdated and blind rituals (Hegde, 2022).

Status of human development

The guidelines provided by the ancient sages through various scriptures over the last 5000 years are relevant even during modern times, except certain outdated religious rituals, which need to be ignored. The prediction about human beings becoming victims of uncontrolled desires has also come true. There has been some variation among the communities living in different regions. With the knowledge acquired, religions practiced and resources available, the living habits of different communities have also varied significantly. Both spiritual and formal education played an important role in their development. Thus, there was a clear divide between different regions. Some regions made faster progress to become developed nations, while some regions remained underdeveloped and a few other regions who made slow progress came in the category of the developing nations. Within every country and even within the communities, there has been a disparity among the families, with regard to their access to the resources and capacity to generate wealth, social status, etc. This was not merely because of their knowledge and physical ability, but also due to discrimination, non-cooperation and exploitation by the powerful members of the society.

Presently, out of the 8 billion world population living in 195 countries and spread over 6 continents, about 8.5 per cent people are living in poverty, earning less than $2.15 per day. There are wide variations in the socio-economic status of these countries and among the communities within each country. The percentage of poor population has been less than 1.0% in the developed countries, while it was the highest - at 34.6% in Sub-Saharan Africa.

Sustainable development goals

To address the sufferings of the people caused by various problems, the United Nations member countries have adopted a set of 17 global goals for Sustainable Development Goals (SDGs) to address the most pressing social, economic and environmental challenges in the world as presented in Figure 1. These goals aim to eradicate poverty, promote sustainable development, and ensure a better quality of life for all. The SDGs address poverty alleviation, food security, water supply, clean energy supply, education, healthcare, gender equality, climate action and inter-regional cooperation. By 2030, these countries are committed to achieving these goals through targeted actions, policies and international cooperation. UN has developed comprehensive guidelines for sustainable development, with equitable,

inclusive and sustainable growth of our future generations.

The United Nations has also developed the Human Development Index to measure the progress of the nation, based on the performance of three important areas of human development, such as health and longevity, educational status and standard of living of the citizens. India has fallen behind on 19 of 33 indicators. Over 75% of Indian districts are below the target for eight crucial indicators including poverty, anaemia, child marriage, domestic violence, malnourished children, access to essential services, modern contraceptive use and tobacco consumption. According to the United Nations SDG Index and Dashboards Report 2023, India secured 112th rank among 166 countries, with an overall index score of 63.5 percent in its progress. Nevertheless, India has made significant progress in important sectors. Most significantly, the poverty rate in India has decreased from 45% in 1993 to around 21% in 2011 and it further declined to 9.89% in 2023 (Niti Aayog, 2023). The prevalence of undernourished people has decreased from 18.2% in 2004-2006 to 16.6% in 2023. There was a significant reduction in maternal mortality ratio from 254 per 100,000 live births in 2004-2006 to 52 in 2023. The under-five mortality rate has also declined from 89 per 1,000 live births in 1990 to 30.6 in 2021. India has achieved near-universal primary school enrolment, with an enrolment rate of 98.3% in 2018. The child marriage rate has declined from 47% in 2005-2006 to 30% in 2015-2016. Access to improved drinking water sources has increased from 73% in 1990 to 94% in 2017 and access to improved sanitation facilities has also increased from 21% in 1990 to 71% in 2017. For the success in all these sectors, social capital has played an important role through community engagement.

Figure 1. Sustainable development goals of the united nations

Support of spirituality to achieve sustainable development goals

It can be observed from the above SDG progress report of India that the performance has been better with social capital inputs, where the activities were not carried out mechanically, but with concern and commitment for the vulnerable sections of the society, by actively involving them in implementing the development programmes. It has been observed that the guidelines and methodologies developed by the United Nations to achieve the goals are not adequate to reach the last in the society. In most of the developing countries, many people chronically deprived of their basic needs, are ignored by the vested interests in the society. The poor and socially backward communities are also unaware about the new development programmes and opportunities. They are generally hesitant to take any risk. In a heterogeneous society, where the poor have to compete with the literate, rich and powerful people for their survival, intelligent and influential people would have grabbed all the good opportunities before the poor could take a decision to take part. Therefore to ensure inclusive development and active participation, the programme implementation team should mobilise the target population at the grassroots level and mentor them throughout, till the completion of the programme. This in a way calls for selfless service, without expecting any benefits in return from them. When the programme implementing team members consider the project work as obligatory or a moral duty, then they feel concerned about the poor and go out of their way to support them. The well-to-do families within the communities should be willing to sacrifice the benefits which they were taking by exploiting the poor in the past. This can happen when the stakeholders are oriented through spiritual awareness that it is unethical and immoral to exploit others. Kindness and concern for others is a part of all the civilised cultures. Thus spirituality and awareness about moral obligations prescribed in most of the religions and cultures can accelerate the process of achieving the SDGs.

Impact of spirituality on sustainable development

The spirituality and our cultural values can help in promoting sustainable development in the following ways.

1. **Motivation of participants for active involvement:** As the poor are ignorant about the benefits of the development projects, most of them keep away from these programmes. Those who have been practicing traditional rituals, do not like to give up these practices. For instance, people who believed in performing religious rituals to get cured of certain diseases do not like to go to any doctor for treatment. Many of them might have also experienced exploitation by some of these doctors. There have been many instances where some of the doctors have removed certain organs of the ignorant and poor for selling them to rich patients in the pretext of treating them for their ailments. However, all doctors are not bad. Hence the community leaders and fellow members in the communities should be sensitised to motivate the target groups to take active part to harness the benefits of the development programmes and come out of poverty. It is probably the progressive members of the

communities who need to realise their righteous duties to help others, instead of exploiting them. Then the development programmes can be accelerated to realise our goals.

2. **Dedication for selfless service:** For the success of any development programme, the programme implementation team should have faith and confidence in the programme. They should make sincere efforts to implement the programme in the true spirit. The Professionals engaged in development should have concern for the target population and interact with them with respect and humanity. Unfortunately this aspect is missing in many professionals. If the project members consider diligent implementation to be their moral obligation, then their communication with the stake holders will be very effective in delivering the services effectively.

3. **Self-discipline:** When Mahatma Gandhi launched the Sarvodaya programme for the upliftment of the poor people in rural India, he prescribed a code of conduct for the volunteers of the Sarvodaya team to maintain discipline and ethical standards. The Sarvodaya volunteers had to take the following eleven pledges to practice. These are: Nonviolence (Ahimsa), Truth (Satya), Self-Discipline or Chastity (Brahmacharya), Non-Stealing (Asteya), Non-Possession (Aparigraha), Physical labour (Sharirashrama), Control of Palate (Asvada), Fearlessness (Abhaya), Equal Respect for All Religions (Sarva-Dharma-Samanatva), Duty towards the nation (Swadeshi) and Removal of Untouchability (Asprishyata nivarana). With this discipline and commitment for selfless service, the Sarvodaya workers were able to motivate the target population with confidence to participate in the development programmes with success. Such disciplines can be followed by engaging Civil Society Organisations for implementing the programme and closely interacting with the communities.

4. **Curb on consumerism:** It can be observed that most of the people crave for more pleasure and possessions for their security and enjoyment. This results in increasing the demand for consumer goods and shortage of essential commodities available in the market. It has been amply demonstrated that without any spiritual base, most of the human beings are not contented with whatever they earn and possess. They have the tendency to compare themselves with others who are more resourceful and powerful and thus remain frustrated. With more wealth, they become arrogant and egoistic and feel angry and humiliated when others do not oblige them. People with spiritual orientation are capable of rational thinking and control their desires. Reduction in personal greed and worldly possessions can reduce the demand for many commodities and the resources available on this earth will be adequate to meet the needs of our people. Control of mind can prevent wastage and reduce pollution. Thus, sustainable

development can be achieved easily.

5. **Non-violence for peace and conservation of biodiversity:** Non-violence is the basic foundation of humanity, preached by most of the religions. Jainism and Hinduism emphasise that even harsh words which hurt the feelings of others is also an act of non-violence. It also includes the protection of the plants and animals, which help to conserve the nature, reduce pollution and ensure harmony in the society. In a peaceful atmosphere, people develop trust among themselves and extend cooperation for mutual progress. This can bring transparency while implementing development programmes, leading to inclusive development of the entire society. If we had realised the importance of nonviolence, there would not have been any terrorism or war, which are keeping the entire world on tenterhooks and making life very uncertain.

Hence, there are many advantages of linking the development programmes with the community groups who respect the traditional culture, righteous duties and spiritual values. This can be done without any major change in the organisational structure and general guidelines suggested by the United Nations.

Conclusion

The objective of promoting the Sustainable Development Goals is to reduce the disparity between the haves and have-nots within the communities and between the regions in the world. The common causes of disparity are uneven access to resources, disparity in education, social and religious taboos and unethical practices by the powerful and wise people to exploit others, either directly or indirectly. The nations participating in the SDGs aim to provide resources, infrastructure and technologies empower the local governments and the local communities to address their challenges and achieve the set 17 goals. However, without the commitment of all the stakeholders, both the participant communities and the officials engaged in programme implementation, the progress is slow. For realising the goals, the target communities are expected to change their attitude and work hard to engage in gainful employment, adopt basic hygiene and sanitation, family planning, good care of their children through proper feeding, immunisation, timely health care and education, control on their consumption, while avoiding the wastage of food and other resources. Simultaneously, the well-to-do members of the communities and the members of the programme implementation team should realise their righteous obligations for the welfare of others, weaker sections of the society in particular. This can address all the hurdles and accelerate the process of achieving the SDGs. As told by Mahatma Gandhi, the world has enough to meet the needs of all the people, but not enough to fulfil their greed. With spiritual and cultural orientation of the stake holders, SDGs can be achieved successfully.

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Role of Ramakrishna Mission's health programme in the transformation of rural health structure

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Abstract

NGOs are pivotal in addressing global issues, notably health, with malnutrition being a significant concern, especially in rural areas. Child malnutrition is alarming in some regions, emphasizing the importance of child and maternal health worldwide. While India has effective health policies, NGOs like the Akshaya Patra Foundation and the Ramakrishna Mission complement governmental efforts. The Ramakrishna Mission prioritizes health, believing in eradicating hunger and understanding the link between nutrition and well-being. Emphasizing rural child, adolescent, and maternal health, it exemplifies health as a pillar of social progress.

Keywords: malnutrition, NGOs, nutrition, Ramakrishna Mission. social action.

Introduction

India is the most populous country in the world. China is in the 2nd spot when it comes to population. The population of our country has reached an alarming level because our land and resources are limited. Especially in rural areas, it is a herculean task to provide the minimum basic facilities to such a huge population. Our population is increasing day by day, but what about resources? What about the distribution of land? Where can we produce food grains to feed such a huge population? These are not just questions, but the biggest challenge in the present context. Providing food, affordable homes, and effective health services to all is a big deal. For that sake, a

scheme is not enough; it is possible only if the government is strongly determined with a good political gesture. Health is still a burning issue in our country, and although the government is improving the condition of government hospitals, these efforts are not enough to fulfill the goals that we have planned to achieve as per the MDGs. The bigger states of our country Like, the U.P. has bigger challenges, such as a shortage of health staff as per the population and an unbalanced ratio of doctors per 100,000 population. Uttar Pradesh (UP) is the most populous state in India and has some of the highest rates of malnutrition in the world; half of all children under the age 5 have stunted linear growth, and 10% are wasted. Singh (2014), in their study, found that the prevalence of underweight, stunted, and height was found to be significantly higher in children of illiterate parents''. Globally, approximately 149 million children under five were wasted, and nearly 17 million were severely wasted. There are now 40 million overweight children globally, an increase of 10 million since 2000. (UNICEF-WHO-World Bank, 2019). It is estimated that by 2050, 25 million more children than today will be malnourished. (Nelson et al., 2009). In India, as per National Family Health Survey 4 (NFHS-4, 2014–15), 38.4, 21, and 35.7% of children below five years suffer from stunting, wasting, and underweight, respectively; the corresponding figures for NFHS 3, 2005–06 were 47.9, 19.8, and 42.5%, respectively. In 2014, the UP State Nutrition Mission (SNM) was established to help improve child and maternal nutrition in the state. The SNM acts as a multisectoral coordinating body within the government to improve nutrition programming across sectors, especially within Integrated Child Development Services (ICDS) and the National Health Mission (NHM). UNICEF financially supports and is a technical partner of the SNM in UP. (UNICEF, 2016, p. 9). The health interventions aim to strengthen and promote comprehensive health for women and girls, particularly in rural and underdeveloped areas, and create a positive and enabling environment for accessing quality healthcare services.

There are multiple challenges before a growing economy, and India is still struggling with those challenges, especially in the field of public health. Health infrastructure is still one of the biggest challenges for the growing economies of the world.

India has one of the fastest-growing economies in the world. In the seventy-three years of its independence, the Indian governments have claimed several achievements—social, economic, and political—to their credit. All successive governments made efforts to build a modern economy to lift people out of poverty and backwardness. In the area of health, the Indian government made several noteworthy efforts, from the "Bhore Committee recommendations" (Duggal, 1991) to the National Health Policy, 2017," to maintain the public health service system to deal with different health issues. However, providing quality health services to all is still a major challenge in India. In such a context, it is quite important to look at the socio-economic, cultural, and political factors that are creating barriers to providing quality health services equally to all and maintaining the health and well-being of the Indian population. (Rani and Wakar, 2018). Thinking of wellness is impossible without the improvement of basic healthcare infrastructure. WHO defines wellness as "the optimal state of

health of individuals and groups," and wellness is expressed as "a positive approach to living." There are two focal concerns: the realization of the fullest potential of an individual physically, psychologically, socially, spiritually, and economically, and the fulfillment of one's roles and expectations in the family, community, place of worship, and other settings."

Providing quality health services is very important for the health and well-being of our country. But it's not possible for the government solely to improve the structures of public health; for that sake, it's better to join hands with the private sector players through PPP mode. Despite all the good efforts and awareness on health and sanitation, government machinery does not rely on its efforts. This is the reason that the government takes the help of various voluntary organizations and NGOs to improve the health situation in our country. The situation is worse when it comes to the issue of child malnutrition. The positive side of the effort is that many NGOs are working very well on the issue of child and adolescent malnutrition. Ramakrishna Mission is one of the prominent organizations that is working continuously and effectively on the issue of child malnutrition. As a research scholar, it was a wonderful experience working with the Ramakrishna Mission on the issue of child health in the Mirzapur and Sonbhadra districts of Uttar Pradesh. Both districts are considered underdeveloped as compared to their counterparts. Mirzapur is a big district in terms of area, and its population is roughly equal to the population of the City of Kuwait. It is very famous for Vindhyavasini Temple, which is considered one of the 51 Shakti Peeths of Devi Durga across the Indian subcontinent. Mirzapur was once upon a time the largest district of India as per the area. The present Sonbhadra district was once part of the Mirzapur district. It is very famous in the carpet industry. Mirzapur district shares its border with Varanasi, Allahabad, and Sonbhadra districts. Mirzapur is divided into 12 blocks. Ramakrishna Mission is working in 8 out of 12 blocks in Mirzapur and one in Sonbhadra district. RKM believes in a rights-based approach, not a charity-based approach. RKM has a well-planned action model known as Ramakrishna Mission's model of health, which is mainly focused on child and adolescent health. The organization has a well-trained team of staff and experts who are responsible for the effective implementation of health-related programs for the beneficiaries. Ramakrishna Mission believes in a humanitarian approach, and it believes in the humanitarian approach of Swami Vivekananda, who always considers humanity above all. Ramakrishna Mission is a unique kind of NGO whose presence is in all the major centers of the world. Health is the real asset of the human being, and believing in this philosophy places much more emphasis on child and maternal health. If a child and mother become healthy, only then can we assume a healthy nation. RKM is working on that population that is not able to avail of the resources and suffers from extreme poverty. RKM is working in the Dalit basti, Mushar basti, Muslim basti, and Adivasi basti. Community mobilizers and staff of the Ramakrishna mission work together for the identification of the population where the health status of the family is not good because those families are more prone to malnourishment. It is the responsibility of community mobilizers to conduct a survey and meet on a daily basis with those families where malnourished children are

available. It has been seen frequently that malnourished children are found in those families who belong to low-income groups and are illiterate too. Once community mobilizers identify the target group, they discuss it with the staff of the Ramakrishna Mission. After discussion in detail, both of them again go to the identified population and discuss in detail with the families. After which, they regularly check the condition of the children and mother and register their names in the beneficiary register, through which they get nutritious food and medicine at a fixed interval. RKM provides nutritious food and free medicine to the families up until and unless the child declares healthily. The health and awareness campaign of the RKM is an effective weapon for the villagers, who are not at all aware of the government schemes and plans. Through various pamphlets and documentary films, doctors and other staff of RKM are continuously informing the villagers of the latest updates about the various welfare measures.

Ramakrishna Mission drives its health programs, models, and vision from the doctrines of Sri Ramakrishna Paramhans: Ramakrishna Paramhans always wanted Swami Vivekananda to serve the poor, the downtrodden, the ignorant, the sufferer, and also the sinner. Swami Vivekananda set out to explore the conditions of people from Kashmir to Kanyakumari. He was moved by the sorrow, agony, and anguish of the people. He believed the notion of "Shiva Jnane Jiva Seva," (Dasarath and Tah, 2023) "He who serves Jiva serves Shiva (Lord Shiva) indeed." Ramakrishna Mission has an emblem or symbol that depicts the synthesis of yoga that Swamiji has in his mind.

Health programmes of ramakrishna mission varanasi

Vivek Sanjivani Program (an overview): Vivek Sanjivani is an initiative for the healthcare and education of the Ramakrishna Mission Home of Service, Luxa, Varanasi. It provides general healthcare through six telemedicine units and six mobile medical units, along with mother-child primary healthcare, adolescent healthcare, community mental healthcare, visual health check-ups, general movement assessments in neonates and infants, and the distribution of nutritional food supplements. It is also engaged in Gadhadhar Abhyudaya Prakalpa (non-formal primary education), value education programs, health education, health education-based and value education-based film development, and the publication of books and research programs. It conducts foundation courses in science and mathematics, online teachers' training, and workshops. Multimedia-based online science and communicative English classes are now being regularly conducted for rural children. This department offered telemedicine services through twelve centers, in which six telemedicine units (TMUs) are stationary and six mobile medical units (MMUs) are roaming.

Telemedicine services: The Ramakrishna Mission provides a virtual alternative to traditional medical care in the form of real-time telemedicine technologies. It helps more people get the medical attention they need, particularly in underserved areas and communities. Saving money while also keeping patients informed about their treatment is made possible throughout the year. When it comes to healthcare, the poor in Varanasi may turn to one of RKM's twelve telemedicine centers.

Telemedicine units (TMUs) of Vivek Sanjivani: Six Telemedicine Units have been established at different locations, viz., Majhawan, Kalwari, and Naugawan (Mirzapur district), Lohara (Sonbhadra district), and Lalganj (Azamgarh district) of Uttar Pradesh, and Bakhpur (Udham Singh Nagar district) of Uttarakhand, for providing medical services to the poor, needy, and underserved. These centers generally provide telemedicine services three days per week on a regular basis. Telemedicine services use Internet communications and cloud-based real-time software solutions to provide clinical services to patients without an in-person visit to the doctor's chamber. IIT Kharagpur has developed 'Matri Seva, a database software free of charge for keeping patients' details. The software has been hosted on a Microsoft cloud-based server to provide easy access to all centers. It is frequently used for primary healthcare, mental healthcare, follow-up visits, the management of chronic conditions, medication management, health education, and other clinical services. The telemedicine programs of Vivek Sanjivani are backed by a 195-bed referral hospital at Ramakrishna Mission Ashrama in Varanasi. The physician's consultations are done from the expert center of Vivek Sanjivani at Varanasi or from the doctor's dwelling place. Several physicians from Kolkata, Anand (Gujarat), and Noida are extending help in the treatment of patients. Specialist doctors provide free services. All received free medicine from the remote TMUs, except in a few cases. Pathological tests like blood pressure, hemoglobin percentage by color card, and random blood sugar (RBS) are done for patients over 30 years of age. Specialist services are offered through telemedicine at the doorstep of the village population. These specialist services include psychiatry, gynecology, ENT, medicine, oncology, and community medicine. People are receiving several major fundamental benefits from Vivek Sanjivani's telemedicine services, such as improved access, cost-efficiency-based service, and quality healthcare facilities and services within the reach of their homes.

Mobile Medical Units (MMUs) health on wheels: In rural Uttar Pradesh, nearly 60 percent of the total rural population lives below the poverty line. MMUs help to conduct screenings and basic diagnoses and provide primary healthcare services for complex medical treatments closer to people's homes. Six MMUs touch several parts of the Mirzapur district of Uttar Pradesh. These units are partly based on telemedicine services. Some patients at two locations are offered in-person doctor's meetings.

Non-communicable disease screening (NCDS) is done for hypertension (HTN), diabetes (DM), oral cancer (OCE), and breast cancer (BCE) among the target age group of 30 years and older through telemedicine units (TMUs) and mobile medical units (MMUs) on the first day of patient registration.

Manasik Soundarya Community Mental Health Program: The Community Mental Health Program is devoted to the evaluation and improvement of the public mental health of poor people affected by mental disorders, emotional disturbances, and/or addictions. The patients from Patewar, Kalwari, Naugawan, Lohara, Majhawan, Lalganj, Manikpur, Ramn Deagar, Gaura, Jalalpur, Deepnagar, and other villages are receiving three-tiered comprehensive psychiatric and neurological treatment for common mental disorders like depression,

anxiety, obsessive-compulsive disorder (OCD), severe mental disorders including psychosis, bipolar disorder, schizophrenia, and major depression and epilepsy. Visual Health Check-up: In terms of ocular health, two main public health challenges in developing nations like India are cataracts and refractive errors. Ramakrishna Mission, Varanasi, offers eye refraction testing as well as 3 Nethra testing at the remote village sites to favor the rural people. Vaccines, viz., polio, penta, tetanus toxoid, inactivated polio vaccine, etc., are administered in villages where the Ramakrishna Mission has been working continuously for decades. RKM offered support to tuberculosis patients to receive free medicine and government benefits.

Distribution of nutritional food supplements: The distribution of nutritional food supplements has continued uninterrupted to date. Nutritional food supplement items (Bajra, Soyabean, Besan, Ground Nut, Jaggery, and Mustard Oil) are regularly distributed on a monthly basis to the poor, pregnant, lactating mothers, and malnourished children of the villages of Mirzapur and Sonbhadra districts, which provide 750 kcal/day and 37 g of additional proteins every day to each woman and child. Films based on health education developed by our department were screened in different areas and viewed by villagers and students.

Promotion of health education: Spreading health education has the potential to improve people's health and the health-related aspects of their daily lives, such as their environment at home and at work. Programs that aim to improve health and prevent illness should include health education in their strategies. This has the potential to initiate far-reaching health advances in caring for marginalized communities. Culturally relevant and specifically designed for rural audiences, these films are used in health education initiatives to increase the likelihood that their messages will be received positively. To empower people in rural regions to take charge of their health and make positive behavioral, environmental, and societal changes, the Ramakrishna Mission has produced documentaries that discuss issues including language and cultural hurdles to health promotion and illness prevention. Films based on health education developed by the health and healthcare departments were screened in different areas and viewed by villagers and students.

Health Education and Film Development: Ramakrishna Mission developed the video ‘Amulya Jeevan’, a cancer awareness film in Hindi, and another, ‘Nishabd Ghatak’, a film based on respiratory problems due to the indoor population in rural areas in Hindi, to create awareness among the vast majority of rural and urban people.

Short films on stories of Sri Ramakrishna Paramhans: The Vivek Sanjivani team also developed short films on the teachings of Sri Ramakrishna Paramhans in English, Hindi, and Bengali.

Non-formal primary education

Gadadhar Abhyudaya Prakalpa (GAP): Under this program, a total of 200 children from poor families in Rampur, Gaura (Mirzapur district), Lalganj (Azamgarh district), and Lohara (Sonbhadra) districts have been enrolled in the mission’s four child-friendly holistic non-formal schooling units. These kids receive holistic education in their natural environment.

They get nutritional snacks on a daily and monthly basis, depending on the items, along with free learning and literacy materials, hygiene and sanitation items, uniforms, and school bags for overall growth and development.

Jivansudha (Value Education Programs): One of the primary goals of the Vivek Sanjivani initiatives is to instill more human values in the young. Having a sense of purpose and enjoying life more as a result of incorporating values into daily decisions is the result of having internalized and applied those values. Vivek Sanjivani has taken on this Jivansudha-value education program, which uses multimedia presentations to illustrate Ramakrishna-Vivekananda teachings for students and adults of varying ages in order to inculcate the attitude of practicing higher ideals in life and to influence young minds right from the school days. Ramakrishna Mission has published the book 'Jivan Mein Safalta' to propagate the ideas presented by the illustrious child of India, Swami Vivekananda. They have started online value education classes for students to foster positive thinking. Sri Ramakrishna's sayings are the inspiration for living daily life based on eternal values. Keeping this in mind, they have developed five films in Hindi and one film in Bangla based on the stories told by Sri Ramakrishna Paramhans. All six films are dubbed in English. They conducted value education programs in several villages where villagers were participants.

Health education: In the slums and rural areas of Varanasi, the Home of Service initiated a new concept of catering knowledge in the area of health and hygiene called the Health Education Department in 2003. The department focuses mainly on the health conditions of children and women. The Home of Service imparts health education by educating children and women by collaborating with the latest technologies, such as multimedia, demonstrations, and talk shows. The health department also provides auxiliary services like vaccinations, training of women in midwifery, hygiene, etc. The Home of Service has a diary wing. Milk collected from the milking cows is given to the patients in the hospitals as well as the personnel of the Home of Service. Doctors and health care professionals are recruited who have passed the Ayurvedic Medical Service course. They are given training by the Home of Service in hospitals to learn the basics of allopathic treatment and surgery. These doctors are called 'Trainee Junior doctors". Non-formal healthcare training programs are given to boys and girls each year. Nursing aids are taught to them. The children of the employees get free coaching in the home of service and are encouraged to attend school regularly. The children also receive classes on value education every Sunday. Children also get stipends of Rs. 50/- monthly. To keep up with hygiene standards and norms, the hospital is equipped with laundry services. The hospital clothes are washed and dried with drying machines. These clean clothes are given to patients and hospital professionals.

Empowering rural women (ERW): Ramakrishna Mission's mission is to provide rural women the tools they need to assert their rights to land, leadership, opportunities, and choices and to have a voice in creating policies and programs, at the very least on a local level. They anticipate that this initiative will boost growth and advance the state of development for the next generation. So that rural women may have access to trade

and finance, sell their wares, and contribute significantly to inclusive economic development, the ERW program also promotes equal rights, opportunities, and participation. The ERW team has started their work in Lohara village in the Sonbhadra district of eastern Uttar Pradesh, an underdeveloped area. They formed groups of ladies in each locality of Lohara village. They have provided financial support to some of the ladies of the Lohara village to start some businesses of their own. They have regular discussions with the members of the women's groups about several rights given to them by the constitution. They discuss microfinance in the groups to work together and save money and use it for other purposes like raising animals and starting small-scale businesses such as weaving, fishing, etc. Healthcare is a basic need for all. Not many can afford to get essential healthcare facilities due to many prevailing challenges. Nevertheless, the Ramakrishna Mission started its first health mission by establishing a homeopathic dispensary. A health mission is incomplete without systematic and pre-defined health and health education programs, because that is the baseline for the implementation of a plan whose ultimate goal is to make a healthy nation. Following are the health programs on which the Ramakrishna Mission and its team are working. They are as follows:

- Child Health and Nutrition Programs
- Jan-Man Swasthya Pariyojana (JMSP)
- Telemedicine Unit (TMU)
- Adolescent Girls's Health and Welfare Scheme
- ERW Program (Empowering Women Supported) by Tata Trust
- Mother and Childhood Care
- Health Education Program
- Gender Education
- Anti-Tobacco

Ramakrishnan Mission understands the issues of child and maternal health effectively and implements them effectively in its flagship 'Jan-Man Swasthya Pariyojana', which makes community health workers always ready to face the challenges related to child and maternal health. Ramakrishna Mission is successful in mitigating child and adolescent malnutrition in a short span of time in the Mirzapur and Sonbhadra districts. Credit goes to the well-trained and amicable staff of the Ramakrishna Mission. Effective accountability and transparency are the keys to the success of the Ramakrishna Mission, which ensures a better healthcare facility for needy families. Through the above-mentioned schemes and health model of the Ramakrishna Mission, we must say that these are not just models but a way of social action that is rigorously working for a healthy, prosperous, and wealthy country.

During my data collection period, I have interacted with the many villagers and discussed in detail their socio-economic, political, health and nutritional awareness, food habits, and knowledge about the government and Panchayati Raj officials of their area. Most of the villagers have very positive feedback about the Ramakrishna Mission. Many villagers strongly said that we have seen welfare measures in the eyes of Ramakrishna Mission because, for them, Ramakrishna Mission is not just an organization but a family that is available for them as and when required. They have a very special bond between staff and community mobilizers (RKM). Apart from providing nutritious food and medicine, the

Ramakrishna Mission is very careful about the needs and necessities of the villagers. Many toilets and hand pumps were made by the Ramakrishna Mission in those parts of villages where people did not have safe and clean drinking water and those who didn't have toilet facilities. Following are the important health programs implemented by the Ramakrishna Mission.

Besides these flagship programs, staff and community mobilizers of the Ramakrishna Mission frequently meet each other to learn about their daily life routines; through this, they have developed a strong rapport. The emphasis in social work has always been on building rapport. Rapport building is an asset of the Ramakrishna Mission. Villagers have great respect for the Ramakrishna Mission because they find that they are always thinking about their welfare with a service motive. RKM staff are in regular touch with the government schools, and they provide all the knowledge and information to all the children that are required of them in their growing years. A dedicated and well-trained team of female staff is responsible for the proliferation of knowledge related to growing girls and the physical and mental changes in their bodies. Talking about the menstruation cycle is still taboo among villagers. Earlier, they were not ready to talk with anybody about their monthly problems, but after the intervention of the Ramakrishna Mission, girls were interested in learning about the remedies and solutions to their monthly and other problems that they frequently faced. Earlier, girls were not using sanitary pads during their periods, but nowadays they are using them because they understand the importance of hygiene. Because of the patriarchal mindset, most of the villagers still have a bias between boys and girls. Villagers provide milk and other nutritious foods only to boys, not to girls, because they find no logic in providing nutritious foods to girls. They have their own mindsets and a lot of reasons to prove themselves right. They strongly oppose the idea that girls shouldn't be given more freedom because once we provide freedom and liberty to girls, they will be much more advanced and probably will go beyond their limits, which is against family values and ethos. Once girls reach the age of 15, most of the villagers still think they should immediately search for a boy and get married because girls are like a big responsibility for them. Most of the villagers are not in favor of providing higher education to girls because educated girls could be rebellious, and once they are rebellious, they are unable to take care of their husband's house in a proper manner. In spite of all these differences, some villagers came forward to raise their voices in favor of girls' education. They don't believe in the early marriage of the girls. With the support and inspiration of the Ramakrishna Mission, they are changing their mindset slowly and gradually, and this is a very positive signal. I, as a research scholar, believe that without the transformation of villages, it would be hard to imagine a transformed, stable, and developed nation because real India lies in villages. I have seen a very interesting thing in villages that the women representatives are electing in large numbers, but they are just the pseudo faces of the representation, because in most of the cases, her husband does all the work whatever is assigned to her as a panchayat representative because their family and in-laws think that politics is not at all a cup of tea for women, which is why their husband is the true representative instead of her. But slowly and gradually, some female representatives are opposing this system, and they take a

stand in favor of this issue. Change is a long-term process, and it is a continuous and natural process. Some women panchayat representatives are a milestone for others who think that they are self-sufficient to stand in front of male-dominated politics. Chhavi Rajawat of Rajasthan is the best example for all those who underestimate her capacity as a woman. After her election as a Gram Pradhan, many women in Rajasthan and across the country have contested and won in the panchayat and similar elections in the country. These people are the real changemakers in society. The Ramakrishna Mission always promotes entrepreneurship and leadership skills among women. Women are doing a tremendous job in the field of rural development. Apart from government schemes, microfinance companies are promoting and giving responsibilities to women in rural areas. Women become self-dependent through self-help groups. Through these techniques, women are capable enough to manage the expenditures of a family as well as play a significant role in their family and society. The family is considered the basic unit of society; if a family becomes empowered, society automatically becomes empowered. Besides health programs, Ramakrishna's mission enables society to do its work on its own without depending on others. Mitigation of child malnutrition is not possible without education and awareness. Awareness is the most important weapon to bring change into society because awareness makes one self-dependent and fearless. Only fearless people can raise their voices, not fearful people. Being educated and fearful is not enough to make a difference in society. It is possible only when people are united. An educated, aware, and fearless society can make a difference in society. We as a country can mitigate or eliminate malnutrition or any other challenge if we become educated, aware, and fearless.

Ramakrishnan Mission understands these issues effectively and implements them effectively in its flagship 'Jan-Man Swasthya Pariyojana', which makes community health workers always ready to face the challenges related to child and maternal health. Ramakrishna Mission has been successful in mitigating child and adolescent malnutrition in a short period of time in the Mirzapur and Sonbhadra districts. Credit goes to the well-trained and amicable staff of the Ramakrishna Mission. Effective accountability and transparency are the keys to the success of the Ramakrishna Mission, which ensures a better healthcare facility for needy families. Through the above-mentioned programs, schemes, and health model of the Ramakrishna Mission, we must say that these are not just models but a way of social action that is rigorously working for a healthy, prosperous, and wealthy nation.

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Innovations in Indian agriculture: nourishing diets through farming systems

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Abstract

India faces the challenge of ensuring both food security and dietary diversity for its growing population. This paper explores how innovative farming systems are being adopted to cultivate a future where healthy diets go hand-in-hand with sustainable agriculture. Crop diversification, biofortification, climate-smart practices, and technology adoption are key strategies being implemented. Despite the promise, challenges remain in terms of access to resources and behavior change. By addressing these and fostering collaboration, India can create a more sustainable and nutrition-secure food system for all.

Keywords: bio-fortification, climate-smart agriculture, crop diversification, dietary diversity, food security, Indian agriculture, malnutrition, Technology.

Introduction

India presents a fascinating paradox when it comes to food security (Agarwal,. 2014). As the world's second-largest producer of agricultural products, India boasts an abundance of grains like rice and wheat. However, this very success story masks a hidden challenge: widespread malnutrition. Deficiencies in essential vitamins and minerals like iron, vitamin A, and zinc plague a significant portion of the population, particularly among children and women. This "hidden hunger," as it's aptly termed, manifests in compromised physical and cognitive development, diminished work capacity, and increased vulnerability to illness.

This paradox compels us to re-imagine Indian agriculture. It's no longer enough to focus solely on calorie intake. We need a paradigm shift towards cultivating a future where food production caters not just to quantity but also to quality—a future where diverse, nutrient-rich foods are readily available and accessible to all. This paper delves into the innovative farming systems gaining traction across the Indian landscape. These practices are empowering farmers to become agents of change, fostering a transformation from food security to nutritional security. Through crop diversification, biofortification, climate-smart agriculture, and the adoption of technology, these innovations offer a glimmer of hope for a future where healthy diets and sustainable agricultural practices go hand-in-hand.

The roots of malnutrition

Understanding the roots of malnutrition in India is crucial (Sahu et al., 2015). While poverty undoubtedly plays a role in limiting access to diverse foods, even seemingly food-secure households can fall victim to hidden hunger. Traditional agricultural practices often focus on staple crops like rice and wheat, which, while providing energy, lack essential micronutrients. Additionally, factors like inadequate storage and improper food preparation techniques can further exacerbate nutrient loss.

Beyond staple crops: the need for dietary diversity

A diverse diet rich in fruits, vegetables, legumes, and bio-fortified crops holds the key to unlocking a future free from hidden hunger. These foods are powerhouses of essential vitamins and minerals, playing a critical role in supporting overall health and well-being. However, promoting a shift towards dietary diversification requires more than just increased production. It necessitates addressing ingrained cultural preferences, tackling market access limitations for non-staple crops, and educating communities on the importance of a balanced diet.

Challenges of malnutrition

India's struggle with malnutrition is not a singular story but rather a complex web of interconnected factors. While the paradox of "plenty and hunger" aptly captures the essence of the issue, a deeper dive reveals the multifaceted nature of this challenge.

Micronutrient deficiencies, the hidden hunger: Beyond the issue of calorie deficiency lies the insidious threat of micronutrient deficiencies, often referred to as "hidden hunger." This lack of essential vitamins and minerals like iron, vitamin A, zinc, and iodine has devastating consequences. It can lead to stunted growth in children, impaired cognitive development, increased vulnerability to infections, and even maternal mortality. The impact of hidden hunger extends far beyond the individual, affecting a nation's overall health, productivity, and economic potential.

Unequal distribution of food: The paradox of plenty is further compounded by the unequal distribution of food. While some regions grapple with inadequate production, others struggle with access due to economic disparities and inefficiencies in the food supply chain. This disparity is often exacerbated by factors like social discrimination, where women and girls, especially in marginalized communities, may have limited access to nutritious food compared to men and boys.

Beyond food security: The traditional definition of food security, which focuses solely on calorie availability, falls short in addressing the complexities of malnutrition in India (Bhatt, 2004). We need to move towards the concept of nutritional security, which ensures access to a balanced diet that meets not just energy needs but also micronutrient requirements for optimal health and well-being.

Impact on future generations: The consequences of malnutrition are not limited to the present. Deficiencies during critical stages of development, like pregnancy and early childhood, can have a ripple effect on future generations. Stunted children are more likely to become adults with compromised physical and cognitive capacity, perpetuating the cycle of malnutrition.

A call for action: The challenge of malnutrition demands a multi-pronged approach. It necessitates not only increased food production but also a focus on dietary diversity, improved access, and targeted interventions for vulnerable populations. By harnessing the power of innovative farming systems, coupled with robust public health initiatives and social awareness campaigns, India can move towards a future where nutritious food is not a privilege but a birthright for all.

Innovations for a nourishing future

Diversification: A key strategy is promoting crop diversification. Traditionally, Indian agriculture has focused on staple cereals. However, initiatives are encouraging farmers to integrate fruits, vegetables, and legumes rich in essential micronutrients into their cropping patterns. This not only improves dietary diversity for their families but also creates market opportunities for these high-value crops.

Bio-fortification: Biofortification involves breeding crops with enhanced levels of specific micronutrients (Dhaliwal et al., 2022). This approach ensures a naturally higher nutritional content in staple foods like rice with increased iron content or maize with higher vitamin A content. Biofortified crops hold immense potential for addressing malnutrition at the community level.

Climate-smart agriculture: Climate change poses a significant threat to agricultural productivity. Innovative practices like conservation agriculture, which minimizes soil disturbance and promotes water retention, help farmers adapt to changing weather patterns. These techniques not only improve overall crop yields but also allow for the cultivation of a wider variety of crops, including those with higher nutritional value.

Technology and knowledge sharing: Digital platforms are bringing vital information and resources to farmers (Mapiye et al., 2023). Mobile apps provide access to weather forecasts, market prices, and best practices for cultivating nutritious crops. Farmer-to-farmer knowledge exchange programs are fostering collaboration and enabling rapid dissemination of successful techniques.

Challenges and opportunities

Despite the promise of these innovations, challenges remain. Access to quality seeds, technical expertise, and stable markets for new crops are crucial for wider adoption. Additionally, promoting behavior change to encourage consumption of diverse and nutritious foods requires targeted education campaigns.

Conclusion

Innovations in Indian agriculture hold immense potential to address the challenge of malnutrition. By adopting diversified cropping patterns, embracing bio-fortification, and integrating climate-smart practices, Indian farmers are paving the way for a future where agriculture nourishes not just bodies but also minds. By addressing the existing challenges and fostering collaboration between farmers, researchers, and policymakers, India can create a more sustainable and nutrition-secure food system for all.

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Sustainable crop production in stress condition: strategies and management

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Abstract

Stress in plants refers to external conditions that adversely affect growth and development and result in poor crop productivity. A wide range of environmental stresses reduce or limit the productivity of crops. These are two types of environmental stresses that are encountered by plants: abiotic stress and biotic stress. Abiotic stress causes the loss of major crops and includes salinity, flooding, drought, extreme temperature, heavy metals, etc. On the other hand, biotic stress is caused by attacks by various pathogens such as fungi, bacteria, nematodes, herbivores, etc., and plants are in nature; they cannot move from these environmental cues. Though the plants have developed different mechanisms in order to overcome these threats of abiotic and biotic stresses, they sense the external stress environment, get stimulated, and then generate appropriate cellular responses. On the basis of different scientists' perceptions, it is expected that the stresses may show their severity under climatic change. Now, there is a strong need to develop tolerant crop varieties to overcome stress like salinity, drought, and waterlogging conditions. Therefore, to reduce stress problems, plant breeders, pathologists, and agronomists should come forward to mitigate these stresses, so according to the past publication, it is clear that in the future, research should be done on integrated methodologies to mitigate stresses so that sustainable production can be achieved.

Keywords: Abiotic and biotic stresses, climate change, genetic and management options

Introduction

Crops stress an assortment of environmental stresses which include, abiotic stresses such as drought, water logging, salinity, extreme temperature, high variability radiation, subtle perceptible changes in atmospheric gases, and biotic stresses. such as insects, birds, other pests, weeds, and pathogens (viruses and other microbes). The productivity of land and water is declining day by day because of

depleting underground water tables and non-scientific conventional practices used to establish various crops. Climate change further complicated the situations where uncertain rain both in terms of amount and frequency, high temperature regimes, frequent floods, and drought adversely affected the yield in total. Evapo-transpiration combines both evaporation and transpiration, and their management is important in improving land and water productivity (Bhatt et al., 2019). During salinity stress, plants tend to activate different physiological and biochemical mechanisms to cope with stress through altering their morphology, anatomy, water relations, protein synthesis, primary and secondary metabolism, and biological adaptations (Ayman et al., 2020). Crop water requirements during the vegetative phase varied due to different crops having difficult crop canopy cover and microclimatic conditions (Akram et al., 2018). To improve land productivity through resource conservation technologies (RCTs), as it is closely linked with livelihood stands under decreased water availability depending upon the geological conditions (Abdelaal et al., 2017). The cumulative effects of all abnormalities in climate parameters create problems for plants as well. Perhaps the best way to test recent memory as transformative biologists is to foresee how plant populations will react to future climate Conditions forced by environmental changes Hypothetical and trial-proven results show that, in light of natural change, populations may move to more favorable territories. The negative impact of climate change is prominent on plants and human civilization. Looking at the present scenario of stress divas, interventions can be given to mitigate this problem (Bhadra et al., 2021).

Stress factors which reduce crop productivity

Water deficit stress, salt stress, imbalances in nutrients (including mineral toxicity and deficiencies), and temperature extremes are significant environmental limitations on the productivity of crops all over the world (Lesk et al., 2016). Plant growth and coop yield are primarily affected by cold, drought, salt, and heavy metals. Climate change is a major threat to field crop production, and ultimately, it affects food security. Due to changes in weather patterns and extreme conditions of flood, drought, and heat waves, they negatively affect flood, water, and energy security, all of which reduce crop productivity (Amanullah, 2020; Shanker et al., 2016).

Types of stress affect crop production.

Stress that affects crops significantly is of two types: (1) abiotic stress and (2) biotic stress.

(1) Abiotic Stress

Abiotic stress causes the loss of major crop plants worldwide, which includes radiation, salinity, floods, drought, extreme temperatures, heavy metals, etc. Abiotic stress is imposed on plants by environmental stress, either physical or chemical. Some stresses to the plants injured them so much that plants exhibit several metabolic dysfunctions. The place can be recovered from injuries if the stress is mild or short-term, as the effect is temporary, while severe stresses lead to the death of crop plants by preventing flowering, seed formation, and induced senescence. Such plants will be considered to be stress-sensitive (Verma et al., 2013). However, some desert plants (ephemerals) can escape the stress altogether (Zhu, 2002). As plants are sessile in nature, they

have no choice but to escape from these environmental cues. Plants have developed various mechanisms in order to overcome these threats of abiotic and biotic stresses. They sense the external stress, get stimulated, and then create suitable cellular responses (Gull et al., 2019).

I. Major abiotic stress limits crop yield.

Drought: Among the environmental stress factors, water is a very important factor that limits the crop yield if there is less drought and if there is more that creates flooding. It has been estimated that drought causes an average annual yield loss of 17% in the tropics (Edmeades et al., 1992), but losses can be much more severe, and total crop failures are not unknown (Flowers, 2004). An extended stretch of rainfall that is below the statistical mean for a region is referred to as a drought.

Agricultural droughts indicate an extended dry period that results in crop stress and reduced crop yields. Drought occurs due to a deficit of moisture in the soil when the moisture is not sufficient to meet the needs of growing crops. Moreover, the severity of stress imposed on crops also depends on their acceptability during different stages of crop growth and development (Tandzi et al., 2019; Shaheen et al., 2016).

Effect of drought stress on the crops are as hereunder:

- Poor Vegetative Growth
- Reduced seed germination and seedling development (Devasirvatham and Tan, 2018)
- Plant height and leaf area were reduced.
- Reproductive growth is severely affected.
- Reduced photosynthesis because of less leaf area.
- Reduced stomata conductance and
- Significant reduction in total dry matter

II. Mitigation of drought stress

- Folior spony 20% DAP +1% kcl during critical stages of flowering and grain formation.
- Spray 3% Kaoline at critical moisture stress.
- Spony of 500 ppm Cycocel (CCC) at 1 ml/liter of water.
- Mulching with 5 tomes to sugarcane or sorghum, which saves moisture.
- Spray of 40 lok NAA (4 ml of Plano Fix in 4.5 l of water).
- Use of drought-resistant varieties (Yadav et al., 2019)

Flood Stress

"Flooding may be defined as any situation of excess water." High intensity rainfall causes a severe flood, resulting in physiological stress on crops. Flooding environment to which plants must adapt if it is a regular cycle or seasonal charge. Vast areas of rainfed crops, particularly in the South and Southeast, are manually affected by flooding.

Types of floods: Flooding can be catastrophic, with flash floods causing major soil erosion and direct physical destruction of crops. These are two typical kinds of floods. One has a short duration over a few weeks and is not very deep, termed a "flash flood," and the other is deep flooding that lasts for a long time, called a

"deepwater flood." False floods are unexpected and inconsolable, and their flooding water level can reach 50 cm in the rain-fed lowlands of the humid and semi-humid tropics of South and Southwest Asia. In these areas, flash floods at the seedling stage of paddy cause very low yields (Hottori *et al.*, 2011).

Effects of flooding stress on plants: Major flooding stresses on plants are as follows:

- Deacy and death
- Wilting
- Abscission
- Epinasty
- Lenticels foronation

Nutrient deficiency and toxicity: Under anaerobic conditions, iron toxicity is high. This leads to an increase in polyphenol oxidase activity. It also caused leaf bronzing and refused root oxidation power.

Important mitigations for flood stress are as follows:

- Providing adequate drainage for draining excessive water from fide
- Spray of growth stardant of 500 ppm Cycocel (CCC) for arresting apical dominance and thereby promoting growth of laterals.
- Foliar Spray of 2% DAP + 1% KCL (MOP)
- Spray of 0.5 ppm brassinolide for increasing photosynthesis activity.
- Apply sufficient K fertilizers.

III. Salinity stress: one of the most common forms of land degradation results from soil salinization. This problem is found throughout the country. However, salinity is predominately a problem in arid and semi-arid regions of the world when the potential for evapotranspiration exceeds rainfall and there is insufficient rain to leach away soluble salts from the root (Miller and Donahue, 1990). In India alone, 7 million ha of land are salt-affected. The impact of salinity on the economic exploitation of land for agriculture and forestry is very severe (Singh and Singh, 1995).

"Salinity is defined as the presence of an excessive amount of soluble salt that hinders or affects the normal functions of plant growth. It is measured in terms of electrical conductivity (EC), exchangeable sodium percentage (ESP), sodium adsorption ratio (NAR), and pH". Therefore, saline soils are those that have saturated soil paste extract with an event of more than 4dSm-1, ESP less than 15, and pH below 8.5 (Avril, 1986; Szaboles, 1994). There are two sources of salinity:

Primary or Natural Sources: This is developed from the weathering of minerals and the soils derived from saline parent rocks.

Secondary salinization: Secondary salinization caused by human factors such as irrigation, deforestation, overgrazing, or intensive cropping (Ashraf, 1994).

Salinization effects are as follows:

- If it affects the chemical properties of the same by changing CEC,
- After the physical properties of the soil, the soil structure is damaged by the defloculation of clay particles, and hydraulic conductivity is

decreased, resulting in a slow movement of irrigation water.

- Soil salinity also affects the soil microflora, which plays important roles in the improvement of soil structure, the decomposition of organic matter, and the nitrogen and sulfur cycle (Lal and Khanna, 1994).

Mitigation and Salt Stress are as hereunder:

- Seed hardening with Nacl.
- Application and Gypsum at 50% Gypsum Requirement (GR).
- Incorporation of Sasbaniya (6:25 t/ha) in the soil before planting.
- Folior spray of 0.5 ppm brassinolode for increasing photosynthesis activity.
- Spray of 40 ppm of NAA for arresting the pre-mature fall of flowers, buds, and fruits.
- Folior application of ascorbic acid alone increased the number of leaves and leat area, while in combination with zinc sulfate, it increased the plant height and total plant biomass.
- Extra dose of nitrogen (25%) in excess of the recommended.

IV. Temperature stress: "Greaves (1996) defined subtropical temperature stress as any reduction in growth or induced metabolic cellular or tissue injury that results in limitations to the potential yield, caused by a direct exposure to temperature above or below the thermal thresholds for optimum biochemical and physiological activity or morphological development.".

High Temperature Stress: Levitt (1920) classified plants into psychophiles, mesophiles and thermophiles according to whether or not they tolerate low, medium, at high temperature. Psychrophiles are those plants whose high temp threshold is 15-20 °C; mesophiles are those plants whose high temperature threshold is 35–45 °C; and thermophiles have thresholds and high temperature ranges from 45–1000 °C Levitt (1980) proposed that the high-temperature injury process progresses from a direct reversible strain, *i.e.*, excess respiration over photosynthesis due to elevated temperature. High temperatures may be experienced by plants on a daily and seasonal basis. Plants may be as affected by prolonged periods of moderately high temperature as they are by short periods of extreme temperature, though the mechanisms for coping with these stresses may differ. Heat stress affects grain quality and yield.

Low Temperature Stress: Plants can also be damaged by a chilling effect leading to physiological and developmental abnormalities and by freezing, causing cellular damage directly or via cellular dehydration. There are many symptoms of low-temperature injuries. Some physiological processes, such as flowering in rice, are extremely sensitive to low temperatures, and damage may occur at temperatures as high as 20 °C. In common, a symptom of low temperature injury to the leaves includes wilting and bleaching due to photo-oxidation of pigments, water logging of intercellular spaces, browning, and eventually leaf necrosis and plant death (Witt and Garfield, 1982). According to Dudal (1976), it is estimated that 15% of arable land is affected by freezing stress.

Crop yields may be reduced in several ways by low temperatures. Crop growth may be directly affected by chilling and freezing injuries by causing physical damage to normal biochemical and physiological functions, thus reducing yield. Low temperatures also reduce potential agricultural productivity by limiting crops or varieties that are grown in particular areas.

(2) Biotic factors affecting crop fields

I. Diseases and insect pests:

Numerous microorganisms, including bacteria, fungus, and viruses, are the cause of diseases. Furthermore, a variety of insect pests that are above-ground and soil-borne have an impact on crop productivity. It frequently encourages the growth of diseases under various climatic circumstances while adversely influencing soil fertility and plant yield. They result in a decrease in the resources that are accessible to plants, which prevents them from producing enough biomass, seeds, and yields. Pathogens and pests can migrate from one area to another due to climate change. The crop genotypes that have been accepted locally are thus exposed to novel biotic stressors. Resistance to pathogen-induced secondary infections is one aspect of the interactions between microorganisms and plants, or microbe-associated molecular patterns. A complex of low-molecular-weight plant metabolites, which are well-characterized for dicotyledonous plants but little understood for monocotyledonous plants like cereal crops, are involved in its production and systemic signal (Dressel Halls and Heckel hoven, 2017). According to Osman et al. (2020), the changing climate is bringing with it new diseases and pests for which there is currently no remedy.Nematodes are mostly responsible for soil-borne illnesses that result in nutrient deficiencies, stunted development, and wilting. Nematodes feed on plant components (Bernard et al., 2017). Parallel to this, viruses can cause harm both locally and systemically, which can lead to growth retardation and chlorosis (Pallas and Garcia, 2011). Conversely, insects and mites damage plants by either laying eggs on them or feeding on them (piercing and sucking). Additionally, insects may serve as carriers of several germs and viruses (Saijo and Loo, 2020).

II. Biotic stress and plant defense responses:

A number of pests, pathogens, and parasites are responsible for infecting plants and inciting biotic stress. The fungal parasites are of two types: necrotrophic (kills host cell toxin secretion) and biographic (feeds on living host cells). They induce vascular wilts, leaf spots, and cankers in plants. Plants have developed an elavorate immune system to combat such stresses (Saijo and Loo, 2020). Plants have a passive first line of defense, which includes physical barriers such as cuticles, wax, and trachoma to avert pathogens and insects. Plants also produce chemical compounds to defend themselves from infecting pathogens (Tariz and Zeiger, 2006). Phytophagous pests respond by identifying herbivore-associated elicitors (HAES), herbivore-associated molecular patterns (HAMPs), or PRR herbivore effectors (Santanaria *et al*. 2013). The second level of pathogen recognition is encircle resistance proteins, which identify specific receptors from a phathogen (Avr. proteins) (Abdul Malik *et al.*, 2020). It is considered an effective mechanism of plant resistance to pests and involves effector-triggered immunity (ETI) (Gouveia *et al*., 2017; Spoel and Dong, 2012). The ETE stimulates hypersensitive responses and

triggers programmed cell death (PeD) in infected and surrounding cells (Mur *et al*., 2008).

III. Polyamine and Plant Response to Biotic Stresses:

Polyamine metabolism has long been known to distort in plant cells in response to insightful changes in plants interacting with fungal (Asthir *et al., 2003*), viral pathogens, and mycorrhiza. It is hard to identify the contribution of polyamine accumulation in infected organs as it is present both in plants and pathogenic fungi. The possibility of controlling fungal plant diseases through specific inhibition of polyamine biosynthesis is most exciting and worth pursuing.

Conclusion and future perspectives

Plants are constantly exposed to a number of adverse conditions in the environment. Being immobile and deprived of a highly specialized immune system, they have developed intricate mechanisms to adapt and survive under various types of abiotic and biotic stresses. According to the perception of scientists, it is expected that the temperature of the earth will increase by 3–5 °C in the coming 50–100 years. As there is a is a continuous increase in temperature and scattered uneven rainfall, the changes of floods as well as droughts are always in consideration. Activities such as excessive use of fertilizers, inappropriate irrigation, and exploitation of natural resources may lead to salt stress to a large extent. Under these circumstances, crop plants will probably encounter more rapidly, concurrently, both biotic and abiotic stresses. Therefore, plant breeders should develop stress-tolerant varieties looking to food security and ensure safety for our farmers. Molecular work is to be done at the genetic level to develop mechanisms in plants in order to prevent different types of stress. Unless responsive mechanisms are developed against biotic and abiotic stresses, the crop will continuously be subjected to such stress problems and ultimately prove a great threat to agriculture. In the future, the role of this review will be to decipher combined stress tolerance in plants due to the required research on tolerant genomic mechanisms. It is now clear from this review that the agronomist and field pathologist are assessing the impact of the intersection between drought and plant pathogens on crop performance. Further, the review will be helpful for physiologists and molecular biologists to design or plan agronomically relevant strategies for the development of broad-spectrum stress-tolerant crops as well as to create management strategies to crack down on stress problems.

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