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Spirulina (*Spirulina platensis*): Superfood for Livestock

Rushikesh Ramchandra Kore[1],N. N. Prasade[2] and Sneha Harishchandra Terde [3]
Department of Animal Husbandry and Dairy Science, College of Agriculture, Dapoli
Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli

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Introduction

Livestock is the key part of an Indian economy. The livelihood of almost 20.5 million people depends on cattle. Compared to an average of 14 per cent for all rural families, livestock generated 16 per cent of the revenue for small farm households.

In the 20th livestock census, goats made up roughly 27.8 per cent of all the livestock followed by cattle (35.94 %), buffalo (20.45 %), sheep (13.87 %) and pigs (1.69 %) (Anonymous, 2019).

In livestock farming, feed is a crucial element that has attracted particular focus to the animals in order to improve animal performance. Numerous studies have been done to determine how adding various feed enhancers can increase feed utilization. Antibiotics were frequently used in animal diets to promote growth. Due to the increased search for substitute feed additives, the use of antibiotics as a feed additive to increase the feed value is prohibited in many nations.

The two main goals to raise the profitability of any animal farm are to lower the cost of feed and maximize the quality of animal products. Finding and utilizing new feed sources is essential for future viability and sustainable animal production. As a result, the new feed resource needs to be highly nutrient-dense and capable of optimizing the quality of animal products. Numerous feed additives have been utilized to increase animal performance and output, but they pose a health risk to the consumer. Spirulina (*Spirulina platensis*), one of these

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brand-new feed sources, is gaining popularity because to its excellent nutritional content. Spirulina contains all essential amino acids, vitamins and minerals. It is also a rich source of carotenoids and fatty acids, especially gamma linoleic acid (GLA) that infers health benefits (Howe et al., 2006). It is edible filamentous, spiral shaped cyanobacterium (Becker, 2007).

Importance of microalgae

A wide spectrum of biologically active compounds has been found in microalgal biomass in the form of protein, polyunsaturated fatty acids (PUFAs), pigments, vitamins and minerals. Further microalgae can be used as an economical unconventional animal feed source, since they are very efficient in converting solar source energy, are not dependent on external environmental conditions and characterized by higher productions per unit area than traditional crops.

The spirulina may flourish in both fresh and saline water. The ancient ingested spirulina, but it gained popularity once again after NASA suggested that it might be farmed for people in space. *Spirulina arthrospira* is a widely grown species that is utilised as a dietary supplement for both people and animals (Muhling *et al.*, 2005).

Due to its link to enhanced rumen microbial crude protein synthesis, spirulina supplementation in ruminants is predicted to lead to proportionate increases in lamb final body weight and average daily growth (Quigley and Poppi, 2009; Panjaitan *et al.*, 2010).

Benefits of Spirulina

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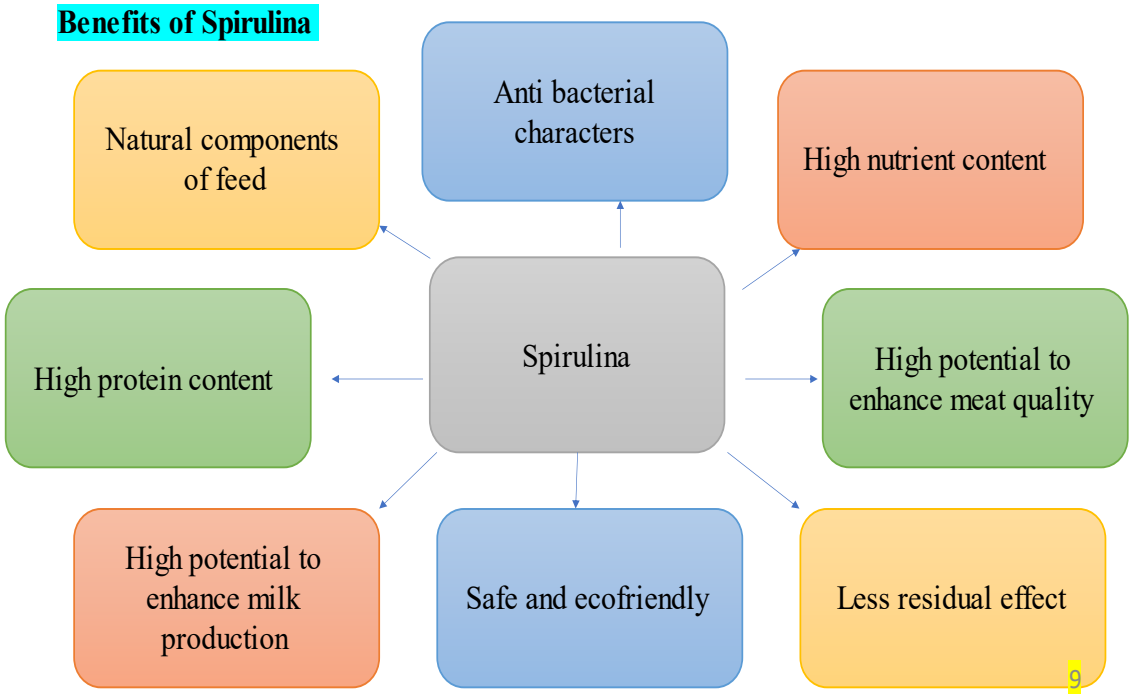

Chemical composition of Spirulina

Sr. No.	Spirulina Content	Percentage
1.	Protein	60-70
2.	Carbohydrates	20
3.	Fat	5-7
4.	Minerals	7
5.	Moisture	3-4

Kanojia et al. (2019) studied and conclude that Protein content in Spirulina ranges from 55% to 70% by dry weight. Spirulina contains high levels of polyunsaturated fats which is about 1.5% to 2.0% and lipid content is 5% to 6%. It is particularly high in linoleic acid, which makes up 36% of all polyunsaturated fatty acids, as well as linolenic acid, linoleic acid, stearidonic acid, ecosapentaenoic acid, docosahexaenoic acid, and arachidonic acid. The nutrients B2 (Riboflavin), B1 (Thiamine), B3, N, B9, F, B12 (Cyanocobalamin), B6, Pyridoxine, D, E, and C are all present in Spirulina (6–8).

Effect of feeding Spirulina on livestock

Animal Welfare

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A major goal for the dairy industry now remoting and in the future is to achieve more balanced breeding conjugated goals that not only emphasize production traits but also are able to take into account health, welfare and environmental sustainability traits. Ponce et al., reported that Spirulina supplementation had increased IgG concentration in colostrum of grazing dairy cattle. Garces et al., evaluated the effects of Spirulina supplementation on oxidative stress, immunity and productive performance during the transition period by grazing dairy cattle. Body weight, body condition score and total antioxidant or human capacity were not affected by Spirulina supplementation. At the same time, cows supplemented with Spirulina multiply during the transition period had a tendency to increase the concentration of IgG in the colostrum and the products, percentage of lactose in milk.

Spirulina and Milk

This has increased milk yield for human consumption, produced ever more efficiently. Modifications in ruminant diet can multiply concentrations of bioactive compounds in dairy products. Methionine-rich feeds such as Spirulina had potential to improve milk production. Spirulina had increased milk fat yield resulted in higher secretion of palmitic acid in milk. Microalgae is suitable protein feed for dairy cows.

Poti et al. investigated the effect of these microalgae as fat supplement on fatty acid profile of cow milk. Spirulina supplements considerably increased rumenic acid concentration in milk (0.75% vs. 0.85%). It was found that cows receiving 200 g of Spirulina daily in the diet had 21% increase in their milk yield . As a result, consumers have dietary benefits from consumption of concentrations of health promoting fatty acids, which improve the human health.

Simkus et al. investigated the potential influence of *Spirulina platensis* on the milk production and serological parameters in Lithuanian Black-and-White cows. In cows fed Spirulina, the average amount of milk fat increased by 17.6-25.0%, the average milk protein increased by 9.7% and amount of lactose increased by 11.7% compared to controls. In addition, diet supplementation with 29.1% of *Spirulina platensis* reduced the amount of somatic cells in milk. Further, in Spirulina-fed cows, the mean amount of nutrition, hemoglobin increased by 8.9% and the erythrocyte count increased by 13.1%.

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A study by Panjaitan et al. found that supplementing *Spirulina platensis* to cattle grazing forages with low crude protein can increase the efficiency of microbial protein production in the rumen, which then can be translated into milk products.

Spirulina increases glucose and unsaturated fatty acids profile, while it decreased saturated fatty acid content of milk from Holstein cow. Similarly, dietary Spirulina decreased saturated fatty acids, whereas it increased monounsaturated and polyunsaturated fatty acids.

Dietary crude protein in animal diets is degraded in the rumen to peptides, amino acids and ammonia. The rumen microbes use dietary crude protein to synthesis their own microbial protein. The production of microbial protein is dependent on the energy provided by the feed. The response to protein supplementation is greatest when crude protein is readily available for microbial protein production. Microbial protein is digested and absorbed along with some undegradable proteins from the diet as metabolisable protein, which is utilised *in vivo* for milk protein synthesis.

Antioxidant Activity

Feeding natural, rather than synthetic, antioxidant could be advantageous to animal welfare and consumer safety. Spirulina supplementation can be incorporated into the diets of fattening lambs as an antioxidant, immuno-stimulant and growth promoter In lambs, it increased the levels of vitamin A and GSH.

Spirulina and meat quality

Meat with superior eating qualities and healthier nutritional composition commands a higher price that consumers are generally prepared to pay. Traditionally, the fat content of meat has been considered as an important source of essential fatty acids and as a calorie-dense nutrient. Modification of animal diets using bioactive feed supplements such as Spirulina is one strategy for producing quality meat.

Kashani et al. investigated the effect of level of Spirulina supplementation on the fatty acid compositions of subcutaneous adipose, longissimus dorsi muscle, kidney, heart and liver tissues in purebred and crossbred Australian Merino sheep. Their results demonstrated significant variations in the growth and the body conformation traits and tissue and organ FA composition in response to the Spirulina supplementation. Spirulina treatment at 100 ml/head/day significantly increased the omega (w)-3 and 6-6 polyunsaturated fatty acid (PUFA) composition in all tissues and organs

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Spirulina and Poultry

Fishmeal, groundnut meal and soybean meal can be partially replaced by spirulina in the preparation of diets of fish, poultry, cattle and domestic animals (Venkataraman, Somasekaran and Becker, 1994)

A vitamin and mineral supplement was not added to the two algal diets because spirulina is rich in these nutrients. Meat colour was not affected.

Conclusions

1. Spirulina is a rich source of proteins, fatty acids, minerals and vitamins, thus making it a potential nutrient-rich feed resource for the pasture-based dairy industry
2. Spirulina feeding in sheep and goat influences the growth performance and meat quality.
3. The combined fodder additive '*Spirulina platensis*' in cows' early lactation period had a positive influence on increase in milk productivity by 21 % ($P < 0.05$). That increased joint yield of milk fat, protein and lactose.
4. Spirulina platensis feeding positively influenced processes of cow estrus and body condition (8.5-11 %).
5. Fodder additive '*Spirulina platensis*' cyanobacteria used in the early lactation period, was economically effective, compared to the cows feeding without that additive.

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