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Rajkumar Agarwal

BSc. Agriculture, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

Astha Bansal

BSc. Agriculture, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

Amarjeet Singh Saini

BSc. Agriculture, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

Ashish Raj

BSc. Agriculture, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

Ashish Kumar

BSc. Agriculture, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

SK Gharde

Assistant Professor, Department
of Entomology, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

Corresponding Author:

Rajkumar Agarwal

BSc. Agriculture, School of
Agriculture, Lovely Professional
University, Jalandhar, Punjab,
India

Bee nutrition and artificial food

**Rajkumar Agarwal, Astha Bansal, Amarjeet Singh Saini, Ashish Raj,
Ashish Kumar and SK Gharde**

Abstract

Bee nutrition is vital for the survival and wellness of bee colonies. Bees need a balanced diet of carbohydrates, proteins, vitamins, and minerals to perform their vital functions such as pollination and honey production. Still, the accessibility of natural food sources for bees, such as nectar and pollen, has been declining due to habitat loss, fungicide use, and climate change. The use of artificial food has raised concerns among experimenters and beekeepers about its potential long-term goods on bee health and behaviour. Some examinations suggest that bees fed on artificial food may have reduced immune function, changed inside microbiome, and behavioural changes, similar as dropped rustling and reduced colony growth. Thus, its essential to balance the use of artificial food with efforts to conserve natural territories and promote sustainable farming practices that support bee populations.

Keywords: Honey bee nutrition, pollen substitute, artificial food, colony, pollen supplement

Introduction

Bee nutrition is an essential aspect of beekeeping, as bees bear a different and balanced diet to maintain their health, productivity, and life. A bee's diet consists of three primary factors nectar, pollen, and water. Nectar is the primary source of carbohydrates for bees and it's collected from flowers and converted into honey. Bees use honey for energy, and it's also an essential food source for the winter when nectar is insufficient. Pollen is the direct source of protein for bees and it's composed from flowers and kept in the hive as "bee chuck". Bees need protein to make and maintain their bodies, including their muscles, glands and reproductive organs. Water is also an essential element of a bee's diet, as bees need water to digest their food, regulate the temperature of the hive, and to adulterate honey for consumption. In addition to nectar, pollen and water, bees also need a variety of micronutrients, including vitamins, minerals and adipose acids. These micronutrients can be attained from a variety of sources, including pollen, honey, and other plant stuff. As a beekeeper, it's important to give your bees with a different range of flowery sources to assure that they've access to a balanced and nutritional diet. Supplemental feeding of pollen backups and sugar syrup may also be necessary during times of limited nectar and pollen accessibility. Overall, a balanced and varied diet is essential for bee health and productivity, and proper nutrition is crucial to maintaining strong and healthy honeybee colonies. While bees primarily calculate on natural sources of nectar and pollen for their nutrition, artificial food can be a useful tool for beekeepers to add their bees' diet during times of failure or to give fresh nutrients for their colonies. Still, it's important to use caution and proper ways when feeding bees artificial food, as it can have negative impacts on bee health and productivity if not used rightly. Artificial food can be classified into two orders sugar syrup and pollen substitute. Sugar syrup is a admixture of sugar and water that can be used to condense a bee's carbohydrate input when natural sources of nectar are scarce. It's important to note that sugar syrup shouldn't be used as a reserve for natural nectar, as it lacks numerous of the micronutrients that are essential for bee health. Pollen substitute is a admixture of constituents that mimic the nourishing content of natural pollen, and it can be used to add a bee's protein input when natural sources of pollen are limited. Pollen cover can be made from a variety of constituents, including soy flour, nectar's boost, and other protein-rich sources. When feeding bee's artificial food, it's important to use proper ways to minimize the threat of damage to the colony. Then are some tips, only feed artificial food when natural sources of nectar and pollen are limited or inconvenient. Follow recommended feeding rates and avoid overfeeding, which can lead to fat and other health problems. Use high-quality and commercially available artificial food to ensure that the nutritive content is applicable for the bees.

Properly mix and store artificial food to avoid impurity and corruption. Cover the bees' consumption of artificial food and adapt feeding rates as demanded. In summary, artificial food can be a useful tool for supplementing a bee's diet when natural sources of nectar and pollen are limited, but it should be used with caution and proper ways to minimize the threat of damage to the colony.

Nutrition Related Risks for Honey Bee

Honeybees are considered as the key pollinators of the commercial crops and other wild species which are useful for mankind. There are many reports worldwide which showcase that there is the high percentage in the loss of the honeybee colony due to several reasons. The reasons can include infection due to different pathogens, exposure of insecticides and pesticides, and nutritional stress due to habitat change and flora related problems. Nutritional stress to the colonies of honey bee can have both long term and short-term negative impacts which can affect the population and the strength.

Some of the nutrition related risks that impact the honey bee colonies are

1. Starvation

Starvation is one of the risks that honey bee colonies face due to long foraging periods and untimely feeding of food which is mainly carbohydrates; this is the main reason of colony mortality in winter season (Brodschneider *et al.*, 2010; Van Engelsdorp *et al.*, 2010) ^[1, 2]. Starvation can be the reason to influence the behavioral changes and food shortage in young workers can affect the life span of population that is foraging and demography of the colony. The nutritional stress can also occur because of the parasites which mainly exerts nutrition stress on the honey bees.

2. Monocultures

Honey bees have the characteristics to gather the mixture of pollens from different species of plants (Wille *et al.*, 1985; Dimou and Thrasyvoulou, 2009) ^[4, 3], this practise helps them to support their balanced and diverse diet. Monoculture is the practise in which honeybees solely rely on single crop species for their food source. The major problem in this is the bee colonies are no able to get the adequate amount of nutrition and lack some of the major vitamins in their diet as well as in the honey. In agricultural settings, majorly mustard, sunflower, wheat and maize crops are grown on a large scale and limited floral resources result in malnutrition and weaken immune system. The weak immune system of the honey bee colonies can become vulnerable to diseases and pests. Few diets are present like sweet clover (Campana and Moeller, 1977) ^[5] and mustard (Singh and Singh, 1996) ^[6] which are better than other diets and can be beneficial to the bees.

3. Genetically modified products

Transgenic products or genetically modified products are the type of products which has the genetically modified material which is engineered by using the technique of biotechnology. The technique is used to introduce the new traits or make the existing traits better in an organism. Honey bees are considered as pollinators and crops are the main resource from which they collect pollen, the GMO crops can produce less nectar and pollen than the normal plants which can have negative effects on the health of honey bees. The effect of *bacillus thuringiensis* (Bt) toxins and other protease inhibitors

on worker bees is they affect the learning and feeding behavior (Ramirez-Romero *et al.*, 2008) ^[7].

4. Residues of Pesticides in the Nutrients

Nowadays, the use of pesticides has increased on a rapid scale and when bees forage around in the landscape, they tend to bring chemicals and other pesticide residues that are applied to the crop for plant protection. There are several studies which show that the ingestion of neonicotinoid pesticides can be lethal and sub lethal to the bee colonies and can have many negative impact on the health. The major impact that the exposure can cause to the bee colony is reduction in the lifespan, impaired learning and reduction in the ability to forage and navigate the location. There are several disorders like colony collapse disorder due to which entire population can die off. There are many ways like integrated pest management strategies which can help to promote the less usage of pesticides and use of alternative methods which are friendly to the environment.

5. Poisoning due to plants

There are several plants which can affect honey bees as they contain certain toxins in them and are considered poisonous to the bees. The colonies of bees mainly collect the nectar and pollen from the plants and when they are poisonous, it can be harmful for the bees as well as to the population consuming the by-products. There are different types of poisoning and some examples are poisoning from the protoanemonin present in the Ranunculaceae family flowers. It is essential for the beekeepers to cultivate the plant properly and keep a check on the potential toxicity that a plant can cause to the colonies when they are exposed to them.

Types and Concentration

The type and concentration of the feed of honey bees can vary on a large scale depending on what the colony requires at a particular time of the year. Different types of bee feeds are given to them in different ratios and concentrations. Sugar (White) is considered the most frequently used sugar substitute that is easily available to provide fresh feeding material to the bee colonies. Feeding is most popular among beekeepers as it helps to promote the growth of the colony in different seasons without much problem. Mainly to feed the sugar there are different ways that the beekeepers use and that is mixing the sugar syrup solution along with water in a ratio of 1:1 or 1:2. The ratio is also given as per the condition that 1:1 sugar syrup is provided to the bees when there is the absence of normal bee flora in the open agricultural fields. The 1:2 sugar syrup is provided in the condition only to complete the requirement of the queen bee to enhance the egg-laying capacity. The concentration of the syrup and the quality of the sugar that is being used is extremely essential to check; as this particular is considered to be the safest and most reliable source of food on dry days. There are different management techniques for every month like in winter the sugar candies are provided in the feeder to the bees and in summer sugar syrup is provided to the colony which should be of a 1:1 ratio not less or more than that.

Sugar Feeders and Types of it

The several methods that are used by beekeepers to feed sugar to the bee colony and one of them is setting up a sugar feeder in the hive. The sugar provided to the colony mainly depends

on the season and strength of the colony. Mainly sugar feeder is a type of container that is used by beekeepers to provide supplemental feed to the bee colony on dry days when there is a scarcity of natural nectar and pollen in the open conditions. The feeders are a great way to help the colonies survive and make less movement out of the hive in search of food in times when there are harsh climatic conditions. The sugar-feeding technique to the bees is the most popular and reliable technique used by beekeepers to help their colony grow effectively without much concern. The only problem that beekeepers face while using these feeders is the ratio of the syrup that is provided to the colonies.

Different types of sugar feeders are used in apiculture to provide artificial feed to the bee colonies. Some of the types that are commercially available and are mostly used by beekeepers are discussed below.

1. Bottom Board Feeder

A bottom board feeder which is also known as the Alexander feeder is part of the hive that replaces the bottom board. In the hive the bottom board is present with the dimensions of 22 inches long, 16.25 inches wide, and 3 inches of height; this board is taken out and the tray which is containing the sugar syrup or the sugar candies is placed in the gap which was created after removing the bottom board of the hive. The particular type of feeder is not used commercially as only a small amount of sugar syrup or candies can be provided to the colonies and the refill is required in small intervals. It is an on-purpose built feeder which is only provided to the beekeepers who have a loose bottom board of the hive.

2. Boardman feeder

It is a type of feeder that is inexpensive in nature as a jar which can be of any material like plastic or glass is kept on the feeding frame at the entrance of the hive. The particular container that is kept with some restriction on the entrance is mainly known as the Boardman feeder. The type of feeder is useful only when a not large quantity of feed of sugar candy or syrup is required to provide to the colony. The method is used by the beekeepers so that they can easily provide the refill of the feed without disturbing the hive on the daily basis. The refill of the sugar feed is to be provided on the daily basis to help the colony grow and remain healthy. The only disadvantage that the feeder has is it can be easily damaged as it is kept outside just at the entrance of the hive.

3. Division Board Feeder

It is the type of feeder that is most commonly used in the Langstroth hives; it is the frame-like structure that has a cavity in it to hold the syrup or candies. The division board hives are used to provide an adequate amount of sugar feed to the colony; they can hold up to 3 liters of syrup without any effort. The dimension of the feeder is the same as the dimension of the frames and the hive box which is created to rear the bees. It is the best way through which the queen can be reared easily, as proper feed is provided to it. The feeder is installed in the hive by removing one of the frames and the use of twigs or wire is done to help the bees not drown in the syrup that is being provided to them. The only disadvantage the feeder has is the hive has to be opened to refill the cavity with syrup, because of this the colony gets exposed to the harsh climatic conditions which are present in the open environment.

4. Top feeder

It is a type of feeder that comes in various dimensions sizes and designs and it is one of the popular methods of feeding sugar feed to the bee colony in an effective manner. In this type of hive, several jars with small perforations in the lid it is placed on the top cover of the hive. Apart from this, an empty hive can also be placed on the hive, and inside it, the jars of feed with small perforations can be kept to protect the jars from any external hindrance. The lid of the hive is mainly placed on the second hive in which the jars are kept and in between two hives the beekeepers can keep holes of 5 to 6 cm to make the process of feeding easy. The feed of sugar can be provided in plastic bags or any container that can hold the syrup properly without spilling. The method is useful but it is not used in commercial apiculture units.

By using these sugar feeders the colonies can be provided with an adequate amount of food without any problem. The only thing that the beekeepers should keep in mind is that the ratio of the syrup should be proper and the feeders should be cleaned regularly to avoid the growth of any mold or other microorganisms. The monitoring of the feeding of syrup should be done in order to keep a check on overfeeding and other issues related to feeds.

Substitutes and Supplements

The basis of honey bee colony's growth and development is proper nutrition. No special dietary needs are needed by honey bees. For growth, expansion, development and maintenance, they need proteins, carbohydrates, lipids, water, minerals and vitamins. The main source of carbohydrates for bees in their diets are nectar and honey, which further bees convert into honey while pollen provides all the essential nutrients, amino acids, fats, vitamins and minerals requirement of a bee diet. The quality and quantity of nectar and pollen that are collected and stored is mostly what determines how many bees are nourished. De Groot (1953)^[8] documented the necessary amino acids for honey bee growth and development, while Haydak (1970)^[9] thoroughly examined the general nutritional needs of honey bees. Bees often prefer natural pollen from a variety of sources for their own requirements but more importantly to feed larvae and will consume pollen before any artificial diets. The artificial diets and dietary formulations of the invention can be used to give honey bees a completely nutritious, easily digestible, complex variety of nutrition. Since abnormalities at one stage have an impact on another, nutrition can be studied at three different stages including colony nutrition, larval nutrition and adult nutrition with varying degrees of intricacy. For commercial beekeeping, numerous feed formulations have been developed by fusing various components and tested by researchers around the globe. [Haydak, 1967; Standifer 1980; Herbert *et al.*, 1980; Schmidt *et al.*, 1987; Chhumeja *et al.*, 1993; Mishra, 1995]^[10].

Carbohydrates based Pollen Substitutes and Supplements

The natural supply of carbohydrate for honey bees is nectar or honey bees which they gather by forages from plants, carry to hive and then store it as honey. Honey bees need carbohydrate to maintain their energy levels. Because adult workers lack significant reserves of carbohydrate, lipids or proteins in their bodies; they are highly dependent on colony food supplies (Kunert and Crailsheinn, 1988)^[11] and cannot go without food for extended periods of time. Barker and Lehner, 1974

^[12] reported about the sugar needs of an adult honey bee worker is 4mg of utilizable sugars per day. In addition, (Barker and Lehner, 1974) ^[12] evaluated a variety of sugars, including L-arabinose, D-xylose, D-fructose, D-glucose, D-galactose, D-mannose, lactose, maltose, melibiose, sucrose, trehalose, melezitose and raffinose, and discovered that sucrose outperformed the others in terms of According to (Jachimowicz and Ruttner, 1974) ^[13], robust active colonies can be successfully given a mixture consisting of 70% powdered sugar, 15% honey and 10% invert sugar (with 1 small bottle of fumidil "B" per 20 kg of sugar) as spring stimulative diet. The colonies consumed more of the sucrose-containing diets than those that contained other sugars (Herbert and Shimanuki, 1978b) ^[29]. Several bee keepers have tried a variety of carbohydrate diets although some were accepted and consumed more readily and in higher amounts, others were rejected or, if accepted, consumed much less. The active areas of honey bee colonies are routinely fed carbohydrates during a honey shortage. To do this, different fruit syrups, sucrose solutions, and invert sugars are fed to the hive. Honey bees eat syrup, which adds two more carbohydrates to the colony's food supply and transports them to food storage combs (De Grandi-Hottmann and Hagler, 2000) ^[15]. According to Rosov (1944) ^[16], a colony of honey bees *Apis mellifera* L. consumes roughly 70 kg of honey annually, with 40-45 kg consumed during the summer, 20 kg during the winter, and 6 kg utilised for wax secretion. In a temperate area, colonies that have finished their autumn feeding require 20 to 25 kg of syrup between November and April (Severson and Erickson, 1984) ^[17]. Bees fed sugar from a feeder were younger than foragers, according to Free (1965). Bee colonies fed on divert sugar (92% sucrose, 8% invert sugar, and 1% pollen) exhibited improved egg production by the queen and an expanded brood area, according to Sheeley and Poduska (1968) ^[19].

Protein based Pollen Substitutes and Supplements

The primary natural protein source for honey bees is pollen. Bees primarily employ pollen in the form of bee bread to feed developing larvae and young bees and to provide the building blocks for muscles, glands, and other tissues. The protein in pollen aids in the development of brood and is also used in the production of royal jelly, which is secreted from nurse bee glands. The queen or developing queen larvae as well as worker larvae up to 72 hours of age are always fed directly. According to Crailsheim *et al.* (1992) ^[22], two 10-frame colonies would need 13.4 and 17.8 kilogram of pollen per year. In contrast to honey, a far smaller amount of pollen is ever kept in the colony, and during non-foraging times, stocks are rapidly depleted (Schmickl and Crailsheim, 2001, 2002) ^[20]. Proteins, lipids, fats, carbohydrates, vitamins and minerals are among the compounds found in pollen, which is made up of crude protein (6%-30%), water (7%-16%), ether extract (1%-14%), reducing sugars (19%-41%), non-reducing sugars (0%-9%), starch (0%-11%), lipids (5%) and unknown (22%-36%). Bee pollen's composition is influenced by other elements as well as the sorts of plants that the bees collect and harvests together. According to Roulston *et al.* (2000) ^[23], the protein content of pollen from various species and geographical areas ranges from 2.5% to 61%. Roulston and Cane (2000) ^[23] explore the difficulties of estimating the nutritional value of pollen merely from laboratory studies of its crude protein content. Honey bees must consume 10 amino

acids that are considered to be necessary for their nutrition (De Groot, 1953) ^[8]. When a colony is actively reproducing or when there is a lot of wax being produced, there is a significant demand for pollen. Bees can partially offset pollens with less-than-ideal quantities of amino acids by eating additional pollen, and if the pollen contains very valuable protein, bees can expel the extra amino acids.

When pollen is of low value, bees cannot physically swallow enough pollen to meet the requirements of what is regarded to be an appropriate level of amino acids. As a result, both the quality and amount of pollen that honey bees gather are crucial. Beekeepers can either transfer hives to breeding circumstances while taking advantage of different flowering species, or they can artificially stimulate their hives with supplemental feeding, to fulfil the requirement of protein content by pollen, to accelerate brood raising. Honey bee colonies may be provided protein-rich diets to promote colony growth in the spring (Mattila and Otis, 2006a) ^[26], during seasons of low or single source pollen income (e.g. Schmidt *et al.*, 1995) ^[27], or in regions or situations where only substandard pollen is available (Somerville and Nicol, 2006) ^[28]. The substitutes is a complete lack of nectar, pollen, or both in the field. The most common form of alternatives for honey or nectar is sugar, preferably in the form of sugar syrup.

Little amounts of thin syrup provided on a regular basis encourage the colony to increase the brood area, whereas large volumes of thick syrup are appropriate for feeding to bees to store for the winter. Paying close attention to the protein sources in the diet is particularly crucial if the goal is to stimulate the colony and boost population levels.

Sugar Feeders

A bee colony can be fed sugar via a variety of techniques, including honey, brown sugar, raw sugar, organic sugar, white sugar, and waste sugar. Since dried sugar is not a desirable diet to feed back to colonies or encourage them to raise additional brood, it is primarily utilised in emergency situations. White sugar is the dietary supplement that poses the lowest danger to bees in terms of digestive issues, which typically present as dysentery in bees. When compared to other sugars and honey, white sugar as a supplement for bees is also economically appealing. Molasses is added to refined white sugar to create brown sugar, the artificial sweeteners. Up to 10% of molasses can be found in brown sugar, which typically causes digestive issues, most commonly diarrhoea in bees and even make them sick. Beekeepers have occasionally been able to get leftover sugar from candy companies or food producers. The drawback of waste sugar is that it could be hazardous to your bees due to chemicals in the sugar. Increasing amounts of salt and starch are toxic to bees. It is not suggested to give used sugar to bees unless you are aware of any additional ingredients that might be present. When raising queen bees, sugar feeding, a source of carbohydrates, can be utilized extensively to ensure the best nutrition circumstances and activate the brood food glands in young nursing bees. Equally significant factors include the sugar fed's content, volume, and quality. Depending on the colony's strength, anywhere between 0.5 and 1 kg of sugar may be piled.

Feed a 1:1 mixture of sugar and water every few days in tiny quantities (1-2 L) to stimulate the colony in the spring or when the queen is being raised. Dry sugar's drawback is that it

gets lost to the bees and spreads throughout the colony. Under humid conditions, this approach is effective. Sugar syrup feeders come in a wide variety of forms. The strategy that is most frequently used and productive is feeding sugar in syrup form. A colony should be fed regularly (weekly) amounts of 5 to 10 liters of processed sugar starting in the fall until it has enough stored to cover its needs for the winter.

Pollen Substitutes

The finest source of protein for honey bee nutritional needs, which include protein, lipids, vitamins and minerals, is naturally gathered pollen. (Herbert and Shimanuki, 1978) [29]. Honey bees need a variety of different amino acids, which are primarily found in pollen. A colony can collect 10-26 kilogramme of pollen annually (Wille *et al.*, 1985) [4]. The productivity of the colony is ultimately impacted by these impacts (Keller *et al.*, 2005). During the wet seasons, pollen shortages can lead to colony reduction or collapse (Neupane and Thapa, 2005).

Soya Flour

Soya flour is rich in vitamins, minerals and nutrients. Many sources have utilised and recommended soy flour, but not all soya flours are created equal. The soya flour is mainly obtained from soyabean cereals. But first, the flour must go through different processing step to remove antinutritional and allergenic factors like trypsin inhibitors, saponins, oligosaccharides etc. Present in soyabean. An expeller processing step is also involve to remove its high (15%) oil content. Flour that was extracted using solvents will have bee-toxic residues. Employing high-fat soya flour is acceptable if the final ingredient mixture has a fat content of 7% or less. Tryptophan, one of the essential amino acids, is lacking. Although soya flour is one of the less expensive supplements, bees do not find it to be very alluring on its own, and the processing of the flour is not always up to the standards needed to utilise it properly for feeding colonies of bees. We can store soya flour in dry place for better meal preparation of honey bees as this raw material contain more protein in it, which is good for bee nutrition. Soya flour is mainly fed to bees for its protein content and mostly, it is given with addition of yeast in it which provides vitamin B to bees. It contains 47 to 50% crude protein in it.

Sunflower and Canola Flour

Moreover, sunflower and canola flour must be processed to reduce their high oil concentrations. Since the protein level is lower than that of soy flour, the products are reportedly less alluring to bees. Sunflower flour's ability to repel bees reduces the amount of food they consume. Avoiding this component in protein supplements is recommended.

Triticale and Sorghum Flour

Although sorghum and triticale flour have been discovered to be particularly alluring to bees, their extremely low quantities of crude protein make them unsuitable as the main component in a mixture.

Torula Yeast

Despite the fact that the nutritional value of the yeast varies depending on the origin, this is typically more alluring to bees than soy flour. A 50% protein content and a 7% fat content are both considered to be appropriate levels. Torula yeast on

its own is not satisfactory since the amino acids are not present in sufficient quantities.

Baker's and Brewer's Yeast

These yeasts offer a more well-balanced range of amino acids than torula yeast, have protein levels that are around 50%, and are more appealing than soy flour. Compared to torula yeast and brewer's yeast, baker's yeast is more expensive. These ingredients range from 1 to 3 percent of mixes in recipes. There are 3 forms of baker's yeast which is fed to honey bees, Active yeast, Fodder yeast and Medicinal yeast. Active yeast contain living *saccharomyces cerevisiae* in it, when active yeast is heated to kill the cells that is called as fodder yeast and when fodder yeast is fortified with certain vitamins it is called as medicinal yeast. All these yeasts are mixed together in sugar water solution as 2:1 ratio in total 5% amount is mixed in solution. In each hive box 250 gm of the yeast syrup is given, 2 times per week during brood rearing season. It is found that colonies of honeybees that fed with medicinal or fodder yeast has more brood than other colonies whereas colonies which fed with active yeast has less brood in them. Brewer's yeast is rich in protein and vitamin B. when fed is prepared, it is mainly prepared with sugar, water, honey and brewer's yeast as its main component. Brewer's yeast includes all of the necessary amino acids, as well as 14 minerals and 17 vitamins. It is one of the best natural sources of the B-complex vitamins thiamin, riboflavin, niacin, pantothenic acid, biotin and folic acid. Brewer's yeast is essential for honeybee colony activity and development, particularly when natural protein resources are limited.

Mixing and Feeding of Pollen Substitute

Pollen is an essential part of a honeybee's diet as it provides the protein that bees need to make and maintain their bodies, including their muscles, glands and reproductive organs. It's also an important source of amino acids, vitamins, and minerals. During times when natural sources of pollen are scarce, such as early spring or late fall, beekeepers may choose to feed their bees a pollen substitute to insure that their colonies have enough protein to thrive. Pollen backups are commercially available and are generally made from a combination of soy flour, nectar's yeast and other constituents that mimic the nutritive content of natural pollen. Mixing and feeding of pollen cover is a common practice among beekeepers to give a supplementary source of protein to their bees when natural sources of pollen are scarce or inadequate. Then are some way on how to mix and feed pollen cover to your bees Choose a high-quality pollen cover There are numerous commercially available pollen backups that you can use. Look for a product that has a good balance of nutrients and is formulated specifically for bees. Mix the pollen cover Follow the instructions on the package to mix the pollen cover. generally, you'll need to mix the powder with water or sugar syrup to make a paste-suchlike thickness. Feed the pollen substitute There are several ways to feed pollen cover to your bees. You can use a pollen cake or a pollen feeder. A pollen cake is a block of pollen substitute placed directly on top of the frames in the hive. A pollen feeder is a vessel that holds the pollen cover and is placed near the hive. Cover the bees Check the pollen cover regularly to insure that the bees are consuming it. Bees may not take the pollen cover immediately, so be patient and cover the hive to see if they're eating it. Adjust the feeding schedule Depending on the

rainfall and the strength of the hive, you may need to adjust the feeding schedule. During times of high pollen availability, you may not need to feed the bees as important pollen cover. It's important to note that while pollen cover can be a useful tool for beekeepers, it shouldn't be used as a relief for natural sources of pollen. Be sure to give your bees with plenty of flowers and other shops that produce pollen.

A pollen substitute is given to honey bees when there is an absence of bee flora or a very small amount of bee flora is present. This is given to honey bees so that the bee colony does not swarm or abscond due to food. When you are feeding pollen substitute to a colony, the quantity of pollen substitute should be determined according to the number of bees present in the hive. There is a wide range of quantities of pollen substitute that are given to bees, but in most cases, the quantity of pollen substitute is 500 g per hive per week in the case of a strong colony. In the case of a smaller colony or a colony with a lower number of frames, i.e., a weaker colony, we only give 100 g of pollen substitute every two weeks.

When the feeding begins, we must take care of the quality of the food given; it should contain the proper amount of protein to fulfil the demands of the bees. For expanding brood nests, the addition of protein supplements is necessary in the absence of pollen or bee flora. Food to the bees can be given in the form of candy, syrup, cakes, patties, or in a loose powder form. Pollens can also be given or fed to bee hives in powdered form without adding any substance, but in their absence, we add small amounts of pollen with the addition of some other components like soya flour or yeast (torula) or sometimes both. The minimum quantity of pollen that is mixed is 5%. Sometimes white sugar is added to make the mixture look more attractive to the bees. The quantity of sugar added is 50% of the dry mixture. Sugar makes pies set like concrete. Mostly, a 70:30 ratio of sugar to water is used. This will inhibit the growth of mould on the patties when they are mixed. Honey can be used as a substitute for sugar, but there is a risk of spreading diseases through honey, so if we are using honey as a substitute for sugar, we need to sterilise with gamma radiation because the patties that are prepared from honey are more pliable and easier for the bees to consume. If the pollen patties are not fed on the day of preparation, then they are stored in the freezer, but to store in the freezer, we have to add food preservatives to the pollen patties so that their nutritional content does not degrade with time if stored in the freezer.

Feeding of the dry mixture should be done according to the required amount by observing the bee population in the frames. The food is placed over the inner cover of each hive. Another method of providing feed is by having an external feeding station where bees have to go by flying and gather their food requirements. In this method, we cannot control the amount of food that a bee colony collects, and in this way, a hive with a high requirement for food supplement may not be able to collect the required amount of food.

Feeding food in cakes or patties allows a larger amount to be fed to each hive according to its requirements.

The method of mixing depends on the amount going to be mixed, the equipment available for mixing, etc. If a large amount of food is going to be prepared, then we use or mix it with an industrial dough mixer. First, we mix all the dry components thoroughly and then we add water until a thick dough is prepared. After that, we take 400-500 g patties out of the dough that we prepared, and then we place them between

the sheets of greaseproof paper. We can store the patties in the freezer until the requirements arise. We can place the pies directly on the top of the brood nest and under the queen excluders to allow easy access.

Table 1: By increasing the amount of pollen and sugar we can make the food supplement more attractive to the bees.

Recipes	
Pollen	5% or plus
Sugar	20-50%
Yeast (Torula)	20-50%
Flour (soya)	20-50%
Vitamins supplements	1-3%

Pollen Substitute

A pollen substitute is prepared from two different components:

- Dry Component.
- Wet Component.

The dry ingredients are fat-free soy flour (150 g) and yeast (50 g). The wet component contains granulated sugar (150 g) and hot water (75 ml).

After preparation of pollen substitute, 200-250 g of pollen substitute is given at one time on blotting paper in the beehive. This food is given at any time except when the pollen is present. The major failure of feeding supplements in the past was the lack of attractiveness to the bees.

Conclusion

In conclusion, sustaining the health and productivity of honeybees requires using beekeeping techniques such artificial food utilisation and bee nutrition. The greatest food source for bees is natural forage, however because of a variety of problems, such as habitat loss and environmental changes, beekeepers now supplement their colonies' diets. The nutritional needs of honey bees must, however, be adequately met, and it is crucial to be aware of the potential risks of artificial food. One of the main nutritional problems that bees encounter is the availability of the right types and concentrations of nutrients. Bees require a balanced diet that contains carbs, proteins, vitamins, minerals, and other essential nutrients. Artificial diet should aim to closely approximate the blend of genuine nectar and pollen in order to maintain the optimal bee health. Unbalanced nutrient ratios can lead to malnutrition, weakened immune systems, and increased susceptibility to diseases and pests. Sugar feeders are often used in beekeeping as a source of carbohydrates. They provide energy to bees but lack the essential components found in natural nectar. While sugar feeders may be useful when nectar is scarce, bees shouldn't depend only on them for nutrition. Beekeepers can correct the nutritional deficiencies caused by artificial diet by using substitute pollen and nutritional supplements. Bees can get energy from substitutes for pollen consisting of carbohydrates, but they lack the rich nutritional content of actual pollen. On the other hand, protein-based pollen alternatives aim to provide the vital proteins and amino acids required for bee development and brood rearing. These substitutes can promote colony health during periods when natural pollen supplies are scarce. Care must be used when combining and feeding pollen substitutes. It is essential to prepare and serve these substitutes in accordance with set standards to ensure bees

receive an adequate amount of nutrition. The timing of supplementation is crucial since different nutritional compositions are needed at different phases of bee development.

The use of artificial food in beekeeping can be beneficial, but it shouldn't replace the requirement to protect and enhance bees' access to natural forage. Environments that provide a range of plentiful nectar and pollen sources should be preserved and restored with priority. Ultimately, a holistic approach that incorporates the preservation of natural forage with the sensible application of artificial food can help with honey bee nutrition and safeguard their long-term health in beekeeping practices.

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