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REVIEW ARTICLE

A Review of Artificial Feeding and Nutritional Diets on Honey Bees

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ABSTRACT

Artificial feeding in honey bees plays a crucial role in beekeeping practices, providing supplemental nutrition when natural forage is limited. This abstract explores the significance of artificial feeding, examining its impact on colony development, honey production, and overall bee health. The study delves into various feeding methods, including sugar syrup and protein supplements, and their effects on colony strength and resilience. Additionally, it addresses the challenges associated with artificial feeding, such as potential nutritional imbalances and disease transmission. Understanding the dynamics of artificial feeding in honeybees is essential for sustainable beekeeping practices and the conservation of pollinator populations. Artificial feeding on nectar and pollen is a pivotal aspect of managing pollinator populations, particularly honeybees. This abstract investigates the implications of supplementing natural forage with artificial sources, emphasizing the influence on bee nutrition, colony dynamics, and overall hive productivity. The study explores diverse formulations for nectar substitutes and pollen supplements, evaluating their impact on foraging behaviour, brood development, and honey production. It further addresses the potential benefits and challenges associated with artificial feeding, including mitigating nutritional deficiencies and promoting pollinator resilience in the face of environmental fluctuations. An understanding of the nuances in artificial feeding on nectar and pollen is crucial for informed apicultural practices and sustainable pollinator conservation efforts.

Keywords: *Artificial feeding, Pollen substitute, Dearth period, Honey production*

INTRODUCTION

Apiculture is a commercial method of rearing honeybees to produce honey and their by-products such as beeswax, royal jelly, bee venom, and propolis. Beekeeping plays a significant role in increasing the income of farmers (Yogesh Kumar, 2014). In India, Apis cerana and Apis Mellifera are primarily reared for their high honey production and reduced swarming behavior. *Apis mellifera* is mainly preferred in beekeeping in South India (Daisy Thomas, 2002). In bee foraging, bees prefer the nearest sources for the collection of nectar and pollen. The distance for foraging could be managed by the honeybees through

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the availability of nectar and pollen (Jane E. Ogilivie and Jessica R. K. Forrest, 2017). Usually, honeybees depend on pollen and nectar as food. In particular, the bee flora has decreased, which affects the honeybees' foraging for honey. Due to the climatic changes in the winter season, bee foraging is affected (Rajesh Kumar *et al.*, 2013). The distance covered by honey bees during foraging is 15 km by A. mellifera and 21.8 km by A. dorsata (Kyle Shacleton et al., 2023). During the dearth period, honey bees were fed artificial feed to increase honey production (M. Kishan Tej, 2015). Honeybees' intake nutrients from pollen during foraging (J van der Steen, 2007). Honeybees feed on the source that contains proteins, carbohydrates, lipids, and other micronutrients. High nutritional content sources are mostly preferred by honeybees (Erkan Topal *et al.,* 2022).

BEE FLORA

Honeybees primarily depend on the nectar and pollen of flowers for their growth and development (Akash *et al.,* 2025). Bee flora varies by area, and bee foraging depends on the availability of flowers near the apiary, which varies by area. The pollen was collected from various plants to satisfy its nutritional needs. (Jasvir Singh Dalio, 2022). The primary nectar sources of the bee were Horse gram *(Dolichos biflorus),* Black Gram *(Vigna mungo)*, Green Gram *(Vigna radiata)* in pulses, Indian rapeseed *(Brassica compestris var. toria)* in oil seeds, Rubber *(Hevea brasiliensis)* in plantation crops, Custard apple *(Annona squamosa),* Citrus *(Citrus spp.)* in fruit crops, Ageratum *(Ageratum conyzoides),* Aster *(Aster thomsoni)* in flower crops. The primary pollen sources of bee flora are Rice *(Oryza sativa)*, Horse gram *(Dolichos biflorus),* Green Gram (Vigna radiata), Chilli *(Capsicum annum),* Capsicum (*Capsicum chinense)* in vegetable crops, Jack fruit *(Artocarpus integrifolia),* Citrus (*Citrus Spp.)* in fruit crops, Chrysanthemum (*Chrysanthemum coronarium*), Cosmos (*Cosmos bipinnatus)* in flower crops (Dr. C.U.Shinde and Prof. Kapil M. Patel (2019)

HONEY FLOW PERIOD

The collection of forage by the honeybees is carried out throughout the year. The honey flow period depends on the flora attributes such as blooming season, flowering period length, attractiveness of the flowers, and floral density. So, the collection of honey depends on the availability of the bee pastures. When there is an abundant supply of nectar, the availability of honey production increases, causing a honey flow period. In some areas, it may also cause 2 to 3 honey flow periods (Jasvir Singh Dalio, 2022).

DEARTH PERIOD

In beekeeping, beekeepers face a significant problem in maintaining strong bee colonies during the Dearth period. In this period, it is tough for the honeybees to forage, and the bee flora is reduced during this season. In a dearth period, the whole honeybee colony may end up dwindling or even cause death (Rajesh Kumar *et al.,* 2013). To overcome the dearth period and to manage the colony without swarming, artificial feeding of nectar and pollen was provided to the honeybees. In artificial feeding, the diet contains proteins, amino acids, vitamins, and carbohydrate-rich sources (M. Kishan Tej.,2015).

ROLE OF PROTEIN AND CARBOHYDRATE

The survival sources for the honeybees are protein and carbohydrate-rich nectar and pollen. The critical roles of proteins and carbohydrates are survival, reproduction, and stress tolerance. An incomplete source of micronutrients could affect the egg-laying capacity of the queen bee (Erkan Topal et al., 2022). Protein-rich artificial feeding during the dearth period to the honeybee colonies could be maintained till the next honey flow period (Rajesh Kumar, et al., 2013). Young honeybees depend on protein for their growth. The development of the brood chamber in the colonies and the development of the hypopharyngeal gland in the bees depend on the availability of the protein supply in the bee colonies (W. T. Chalmers, 2016). In the first six days of adult bee life, it consumes more pollen protein to develop mandibular and pharyngeal glands (Degrandi-Hoffman et al., 2010). The primary energy source of the honeybees is carbohydrates. Carbohydrates play a significant role in the development of adult foragers (Brodschneider and Crailsheim,2010)

METHODS OF FEEDING

Pail feeding

The small bucket lid is poked with the finishing nails, and the bucket is filled with sugar syrup. It is placed upside down on the inner cover with the hole. The empty box around the pail is placed with a heavy lid with a rock on top. With this method, 5L of syrup could be fed at a time.

Hive top feeding

Hive top feeders are the commercial type of hive feeder, which is placed at the top of the hive. A straw was placed in the feeder to help the bees avoid drowning.

Baggie feeding

The syrup is filled in a resealable plastic bag and is used for feeding honeybees. It is placed at the top of the beehive, and a hole is made in the plastic bag for easy access to the honey bees. To prevent the bag from squishing, a rim is placed underneath the inner cover.

Barrel feeding

The barrel feeding method is used to maintain a higher number of colonies. The barrel is placed in the yard. A sufficient amount of straw is placed in the barrel to prevent the drowning of the honey bees.

SUPPLEMENTAL FEEDING

SUGAR SYRUP

When it becomes necessary to prevent famine, beekeepers feed sugar (sucrose) syrup to their colonies, especially in the autumn, to supplement their winter storage. The common belief is that feeding colonies will increase the number of broods raised. However, experiments with syrup feeding revealed varying effects on brood rearing, and they proposed that these variations might have been related to the season and the amount of syrup fed. We examined the amount of sugar syrup consumed by colonies in the spring, summer, and autumn, as well as its impact on colony weight, brood raising, and pollen collecting. We supplied both diluted and concentrated sugar syrup to the colonies (J. B. Free and Yvette Spencer Booth,1960). Sugar syrup was prepared by dissolving the beet sugar in water at a ratio of 1:1. During this sugar syrup preparation, et al. boiled potable water is used (Erkan Topal et al., 2022), for artificial feeding, Sugar Syrup is prepared by mixing 200g of Sugar and 20g of honey in 1 Liter of water, resulting in a solution with high glucose content. The result of the observation of artificial feeding is complete utilization of the feed and increased cells filled with honey (K. R. Neupane and R. B. Thapa, 2005). The combination for preparing the sugar syrup is 1000ml of water and 1000g of sugar, which results in the increased production of honey (Azza T. Ashour, 2008). The sugar syrup is fed in a thicker consistency, which contains 70% sucrose. The ratio of sugar syrup is 2:1 with sugar and water. It could help in the development of the brood chamber in the beehive. Sugar syrup, which is fed to the honeybees, contains 50% sucrose. The sugar syrup is made in a 1:1 ratio of sugar and water, which helps increase the nutrient content in honey bees (Zachary Huang, 2018). The study analyzed 29 royal jelly samples from May to August 2012, comparing the composition of royal jelly from bees fed sugar and honey. Results showed no significant differences in water content, proteins, fructose, glucose, sucrose, pH, total acidity, and electrical conductivity between the two types of feeding. These findings are crucial for beekeepers producing royal jelly and have practical applications in the field (R. Balkanska *et al.,* 2013).

RICE BRAN SYRUP

An alternative to off-season sugar supplement feeding of honeybees is sugar syrup (sugar and water at a ratio of 1:1), rice bran syrup (100g rice bran in 1 Liter of water is soaked for 4 hours, which is filtered through a muslin cloth. Filtered 1 Liter of rice syrup is added with 200g sugar and 20g honey (K. R. Neupane and R. B. Thapa.,2005). Honey's fermentation is limited or delayed due to a shortage of nitrogen, which also stimulates the development of unpleasant sensory chemicals such as sulfur derivatives. Natural supplements have been researched as low-cost alternatives, primarily to correct the nutritional shortage of nitrogen in honey during mead production. An experimental method. The rice bran and soybean meal extracts were first physicochemically characterized. The fermentation of three yeasts (Saccharomyces bayanus Premier Blanc, Saccharomyces cerevisiae Montrachet, and Saccharomyces cerevisiae Safbrew T-58) In honey, 30 g/L rice bran or soybean meal extracts were tested. The studies compared must fermentations with commercial supplements (30 g/L) as well as control trials. Except for reducing sugars, the examined attributes of the extracts differed significantly. Soybean meal extract fermentations had the highest cell densities and consumed the most glucose, fructose, and ethanol. When soybean meal extract and a commercial supplement were combined, glycerol concentrations increased marginally. The control trials using Saccharomyces strains Premier Blanc, Montrachet, and Safbrew T-58 yielded the highest levels of succinic and acetic acids. No formic

or lactic acids were generated. The results suggested that the extracts might be utilized as low-cost alternatives for rectifying the nutritional shortfall of nitrogen in honey since their effect was comparable to that of synthetic supplements (Geiza Suzart Araujo et al., 2021).

MAIZE SYRUP

Maize syrup (100g of maize white powder in 1 litre of water, soaked for 4 hours and filtered through a muslin cloth. Filtered 1 liter of maize syrup is added with 200g sugar and 20g honey (K. R. Neupane and R. B. Thapa, 2005). High fructose corn syrup is a maintenance food for caged honeybees. Corn syrup is produced using the glucose isomerase process, which converts glucose from hydrolyzed corn starch into a mixture containing glucose and a high level of fructose. The high fructose corn syrup is called an economic sweetener. The advantages of high fructose corn syrup are lower cost and feeding convenience. Its sugar composition closely resembles of honey (Roy J. Barker and Yolanda Lehner, 1978). The combination of Maize flour + Vitamin B complex, Maize flour + Vitamin B complex + Egg Yolk, Maize flour + Vitamin B complex + Methionine is fed as the artificial feed for the honeybees. The feed was prepared by mixing each combination mixture with the sugar syrup in a ratio of 11:21. The result of this feed was an increased number of brood chambers (Arshed Makhdoom et al., 2000). The decline in honeybee populations has led to a need for a better understanding of key factors impacting their health. Malnutrition in honeybees is linked to immune system impairment and increased pesticide susceptibility. Beekeepers often feed high fructose corn syrup (HFCS) or sucrose after harvesting honey or during periods of nectar dearth. Chronic feeding of these carbohydrate sources elicited hundreds of differences in gene expression in the fat body, a peripheral nutrient-sensing tissue. These differences included genes involved in protein metabolism, oxidation-reduction, tyrosine and phenylalanine metabolism, and carbohydrate and lipid metabolism (Marsha M. Wheeler and Gene E. Robinson,2014). A study found that bees rely on alternative crops like maize during periods of pollen deficiency. Maize pollen has a low concentration of histidine but more essential amino acids than mixed pollen. Consuming pure maize pollen diets reduced brood rearing and lifespan, but no immunological effects were observed. This supports the assumption that bees rely on alternative crops for food (Nicole Höcherl et al., 2012). This study analyzed the carbohydrate composition of high-fructose corn syrups (HFCS) and sucrose syrups (SS) using GC-MS. Fructosyl-fructoses and unknown carbohydrates were detected in HFCS, while SS was characterized by high sucrose content. Hydroxymethylfurfural (HMF) content in beekeeper samples was more variable. Fructosyl-fructoses were found mainly in HFCS-fed honey (Ana Isabel Ruiz-Matute et.al,2010). A study aimed to improve the nutritional value of corn pollen by mechanically crushing its external pollen wall. The results showed that crushing corn pollen increased diet digestibility and hemolymph protein content while decreasing pollen consumption by 39.88%. However, it did not affect HPG size or thorax weight. The findings could be beneficial for beekeepers in areas with corn monoculture (Eslam M. Omar et.al.,2022)

FRUITS SYRUP

Banana syrup (100g ripened banana is soaked in water and blended, filtered using a muslin cloth. Filtered banana syrup is added with 200g of sugar and 20g of honey), Pumpkin syrup (100g of boiled and hard core removed pumpkin in 1 Liter of water is blended and filtered using a muslin cloth. Filtered syrup is added with 200g of sugar and 20g of honey. The honeybees utilized 99.5% pumpkin syrup and 96.7% banana syrup, resulting in an increased number of filled honey cells and no brood frames in the colonies (K. R. Neupane and R. B. Thapa, 2005). Grape syrup and grapes contain so much fructose that it is commonly referred to as 'Grape sugar.' Bees are attracted to the ripened and crushed grapes. Grape juice was toxic to the bees, but commercially available grape syrup was attractive and nutritious for bees. For the experiment, they used High fructose corn syrup (Isomerase 100 brand), Grape syrup (White Grape juice with 68 brix concentration), Sucrose (Table sugar), Honey (Unfiltered, unhealed from mixed flora) (Less than 1 year old). The results from feeding different types of syrup show the various levels of sugar content (Roy J. Barker and Yolanda Lehner, 1978). The combination was prepared with fruits to feed the honeybee colonies during the off-season period. The preferred fruits for making the mixture were Plum (*Prunus persica*), Apricot *(Prunus armeniaca*), and Apple (Malus sp.), resulting in the consumption and acceptance of the honeybee colonies being 100%, which also helps in the increased production of honeybees (Pande Rachna and

Karnatak A. K.,2013). During the dry months of June and July, the beekeeping business suffers from a lack of nectar and pollen. Ripe neem fruits are in season, and their pulp is available; yet, as the pulp is discarded in nature, we have been tempted to feed the bee colony during this time of year. The pulp of neem fruits was removed and combined with sugar syrup (1:2:1, ripe neem fruit pulp: water: sugar) to create a syrup that honeybee *(Apis mellifera)* colonies could consume. This syrup served as a natural food source and a nectar and pollen substitute for the bee colony during the flower shortage. Approximately 2.42 and 2 times greater than sugar syrup-fed colonies, respectively, were detected in the highest enhanced brood and honey storage areas of the neem fruit pulp syrup and sucrose syrup-fed colonies, which were 64.67% and 58.41% and 26.67 and 28.02%, respectively. In comparison to control and sugar (sucrose) syrup-only fed colonies, the feeding of ripe neem fruit pulp mixed with the sugar syrup enhanced honey production and bee colony multiplication by approximately two and three times, respectively (Akhilesh Singh et al.,2012)

FLORAL SYRUP

The syrup, which was made from the extract of the flower mahua (Bassia latifolia), contains both fructose and protein. The result observed in the feeding is increased honey and propolis production (Ramesh P Singh,2015).

SOYBEAN SYRUP

For honey production during the dearth period, artificial feeding is provided as soybean meal (60 mesh size) is autoclaved at 15Psi for 30 mins, and 250g of sugar and 50g of yeast are added and blended. With this mixture , add 100ml of water and 50g of skim milk powder, and make it a smooth dough. The result from this box is 7.12kg of honey (Tahir Abbas *et al.,* 1995). The experimental study explained that feeding soy Flour (16.7%), parched gram (16.7%), brewer's yeast (16.7%), sugar (33.3%), and glucose (16.7%) as the diet for the honeybees. The result observed an increased number of sealed brood chambers in honeybee colonies, and the number of frames in the super chambers has also increased due to the increased honey production (Rajesh Kumar *et al.*, 2013). The mixture for artificial feeding is soybean flour + Vitamin B-Complex, Soyabean flour + Vitamin B-Complex + Methionine, which results in the increased production of honey and the increased number of brood chambers (Arshed Makhdoom *et al.,* 2000). An experiment was carried out to create a low-cost, adequate pollen substitute for managing honeybee (Apis mellifera) colonies during lean periods. Six different pollen substitutes were given to bee colonies: full-fat soy flour (FFSF), roasted full-fat soy flour (RFFSF), germinated soybean flour (GSF), defatted soy flour (DFSF), roasted defatted soy flour (RDFSF), and soy protein concentrate (SPC). The effects of these substitutes were compared to the control group, which received no feeding, to ascertain their effect on the desired characteristics of the bee colonies. The percentage of each diet that was deemed palatable was over 60%, according to the results. After feeding in every diet combination—SPC first, then GSF, DFSF, FFSF, and RDFSF—a progressive rise in brood area, honey store, and pollen store was noted. The study found that RFFSF had the least desirable parameters, but all diets were significantly superior. Bees' foraging activity increased in colonies fed pollen substitutes, and SPC was the best substitute during the dearth period (Rachna Pande.et.al.,2011). This study investigates the impact of various supplemental diets on honeybee health and colony development. The research found that honeybees consumed significantly more Diet 1(45 g soybean flour + 15 g Brewer's yeast + 75 g powdered sugar + 7.5 g skimmed milk + 7.5 g date palm pollen + 200 mL sugar syrup supplement with Vitamin C) compared to other supplemented diets. This diet significantly improved pollen load, worker-sealed brood area, population strength, and honey yield. The study also found that the control group had fewer biological parameters. The findings suggest that supplemental diets can improve bee health and colony development in situations of insufficient pollen availability and diversity (Saboor Ahmad *et al.,* 2021).

PULSES SYRUP

Black gram flour (550g) is mixed with 250g of sugar and 50g of yeast. To this mixture, 100ml of water and 50g of skim milk powder are added, forming a smooth dough. The result from the box is 8.62kg within a 3-month period. They also observed an increase in the number of frames for honey production (Tahir Abbas et al., 1995). Artificial feeding was provided to the honeybees by grinding chickpeas, green gram, germinated horse gram, and germinated pea into flour. This feeding results in the finding that pulse

flour was the protein substitute for the honeybees in the scarcity of natural pollen (Rachna Pande and A. K. Karnatak,2014). The different types of combinations were based on the mixtures of the various flours. The combinations were oats flour *(Avena sativa)* 50% + Rice flour *(Oryza sativa)* 25% + Anise flour *(Pimpinella anisum)* 25% + Honey, Fennel seeds flour *(Foeniculum vulgare)* 50% + Gram flour *(Cicer arietinum)* + Honey, Rice flour (Oryza sativa) 25% + Pea seeds flour *(Pisum sativum)* + Fennel seeds flour *(Foeniculum Vulgate)* 25% + Fenugreek seeds flour *(Foeniculum vulgare)* 10% + Honey, Mixture of Beans flour *(Vigna mungo)* 50% + flour of fennel seeds *(Foeniculum vulgare)* + Honey, Mixture of dried White Kidney Bean seeds *(Phaseolus vulgaris)* 50% + Bean seeds flour *(Vigna Mungo)* 35% + Coriander flour *(Coriandrum sativum)* + Honey, Gram flour*(Cicer arietinum)*50% + Fenugreek flour *(Trigonella foenumgraecum)* 10% + Cumin seeds flour 40% + Honey(Mohammed Z. Aly.,2014). The study evaluated sprouted pulses as pollen substitutes for Indian honeybees to enhance colony strength and honey production. Six different pulses were tested, with horse gram showing higher acceptance and a gradual increase in colony parameters. All diets were found to be significantly superior to control, with data on cost and shelf life provided (V. MARY FLORET AND S. MANICKAVASAGAM,2022).

FISH MEAL SYRUP

Pacific herring meal is the cheapest type of artificial feeding given to the bees. We need to dilute the protein level to 23%, which is suitable for the broods. It contains high amounts of amino acids 1-lysine and 1-arginine, which are used for the development of brood food glands and elaboration of brood food. The food contains moisture-7.7, Protein-71.6, Fat-7.9, and Ash-11.0, where fish meal was readily acceptable by honeybees. Fish meal syrup contains high levels of protein. (W. T. Chalmers.,2016).

SYRUP WITH MICROORGANISMS

In the experiment, the diet given for the honey is Spirulina (16.7%) + Honey (83.3%), Defatted Soy Flour (20.7%) + Brewer's Yeast (20.7%) + Spirulina (8.3%) + Sugar (33.3%) + Glucose (16.7%). Through this artificial feeding, the strength of the bee population has increased in the colonies (Rajesh Kumar *et al.,* 2013). Liquid yeast (Candida tropicalis) + 750ml of water + 1000g of sugar provides the lowest number of queen colonies. A mixture of 1000g of Sugar + 250g of dried brewer's yeast (Saccharomyces sp.) + 750ml of water is used for artificial feeding. The result of the process was the development of colonies with an increased number of brood chambers (Azza T. Ashour, 2008). Bee disease is a significant concern for apiculture.

Researchers, as it can cause colonies to disappear due to rapid disease transmission. A study using sugar syrup feeds with prebiotics and probiotics, Enterolactis Plus, for three weeks showed a significant reduction in bacteria in bee digestive tracts, while intestinal colonization with beneficial bacteria improved health status and bioproductive index in the studied colonies (S. Pătruică and D. Mot.,2012). Nosema ceranae, a microsporidian fungus, affects honey bees' midgut epithelial cells. Food supplementation with prebiotics and probiotics may help control N. ceranae. Tests on dietary fiber prebiotics acacia gum, inulin, and fructooligosaccharides, as well as commercial probiotics Vetafarm Probiotic, Protexin Concentrate single-strain, and Protexin Concentrate multi-strain, showed significant reductions in spore numbers and mortality. Protexin Concentrate single-strain was promising for reducing N. ceranae proliferation and increasing bee survivorship, even compared to healthy, non-infected bees (Daniel Borges et.al,2021). The European Union's ban on Fumagillin-B has prompted researchers to explore sustainable strategies to control Nosema ceranae, a microsporidium affecting bee health. Gut microbial symbionts, including bifidobacteria and lactobacilli, are being studied for their potential to protect bees. A study comparing four treatments showed that dietary supplementation of gut bacteria, including bifidobacteria and lactobacilli, significantly reduced the level of Nosema ceranae in bees eight days after infection. This marks the first attempt at applying bifidobacteria and lactobacilli against Nosema ceranae in honeybees (L. Baffoni *et.al,*2022).

ARTIFICIAL FEEDING OF POLLEN

Substitution for the pollen by artificial feeding. Where 50g of bee bread with 20ml of water to form a paste. Again, the mixture was added to the 200g of honey and ground in the mortar. Cotton seed meal and dry skim milk are mixed in a 4:1 ratio, and 40g of this mixture is then combined with 200g of honey. Additionally, 20 ml of water is added, and the mixture is ground using a mortar (MYKOLA H. Haydak, 1939).

In bee colonies, protein flow was maintained by the artificial feeding of pollen during periods of fluctuation. The components for making artificial feeding of pollen are soya flour, beer yeast Steen(3 parts), calcium caseinate flour and whey protein flour (3.2 parts), sucrose solution (50%), and 10 parts of linseed oil (J van der Steen, Steen, 2007). Pollen substitute diets were followed in the artificial feeding of the honey bees. The protein pollen substitute is a mixture of bread yeast powder, powdered beet sugar, inverted sugar syrup (70% water and 30% sugar), sunflower honey, sunflower seed oil, and soybean flour (Oskay, D., 2021). C. *criticus* (Pink rock-rose) pollen Sugar Syrup + Water, P. somniferum (Opium Poppy) pollen, Sugar Syrup + Water, Mixed Pollen, Sugar Syrup + Water, Commercial Bee Cake, and Sugar Syrup + Water were fed as artificial diets to honey bees (Erkan Topal *et al.,* 2022). Fresh pollens of *Acer, Castanea, Cistus, Erica, Quercus, Salix, and Taraxacum were blended and made into pellets (Cedric Alaux,* 2010). A study in Saudi Arabia tested the effects of alternative protein feeding on honeybee performance, feed consumption, brood-rearing activity, and bee bread storage. The study found that honeybees preferred the commercial product Feedbee®, followed by date paste and mesquite diets. The highest consumption was recorded in colonies fed Feedbee®, compared to date paste, mesquite, and corn gluten diets. The study recommends using mesquite pod flour and date paste as pollen substitutes during dry seasons to enhance honeybee colonies' performance (Abdulraouf Mohamed,2020). Honeybee colonies rely on floral resources for nutrition, particularly pollen. However, intensification of agriculture and landscape alteration are affecting foraging areas, leading to disparities in floral resource abundance, type, and diversity. A study tested the impact of pollen diet quality and diversity on young nurse bees' physiology and tolerance to the microsporidian parasite Nosema ceranae. Results showed that pollen quality affected both nurse bee physiology and tolerance to the parasite, while diversity had no effect. The study suggests that pollen quality and diversity can shape bee physiology, helping to understand the impact of agriculture and land-use intensification on bee nutrition and health (Garance Di Pasquale,2013).

EFFECT OF ARTIFICIAL FEEDING

Honeybees were fed with artificial feeding and maintained their diet with protein-rich feeds. The commercial artificial feeds were Healthy Bees, Ultra Bee, Global, Bulk Soft, Mega Bee, and AP23. In this experiment, they observed that artificial feeding could increase the colony performance and health of commercially managed bees (Vincent A. Ricigliano et al., 2022). Honeybees were fed artificial feed, including sugar syrup and pollen, to the queen bees. The result was observed in the queen bees at the colony, where the size of the queen cells increased, along with their length and weight (Slobodan Dolasevic *et al.,* 2019). Honeybees were fed sugar and water at a 3:1 ratio, supplemented with vitamin C (Biofactor, Poland) at a rate of 1.8 mg per kilogram of syrup. As a result of artificial feeding of vitamin C, the weight of the honeybee larvae increased, and swarming of bees during the dearth period decreased by 33% (Marek Farjan *et al.*, 2012). By providing supplementary feeding and quality artificial pollen to the honeybees, it shows the results of a healthy honeybee Colony and increased life span of the honeybees during the winter and dearth period (Erkan Topal et.al,2022). Improper and unequal supply of pollen to the honeybees may lead to abnormal development of brood and decrease the life span of worker bees (Abdulraouf AMRO.et.al.,2016). Due to the artificial feeding of pollen, honeybees resist the disease and develop the immune system in the bee colony (Cedric Alaux,2010). This review examines honeybee feeding practices in Ethiopia, focusing on the status of feed supplements and honey production potential. Honeybees face starvation due to a lack of feed, especially during dry seasons. Despite this, some beekeepers practice supplementary feeding to improve honey yield and escape dearth periods. Common feed supplements include sugar, roasted spiced pulses flour, barley flour, honey, water, sugar syrup, and honey with water. Traditional beekeeping practices in Ethiopia result in low-quality honey (Merhun Lamaro Lango and Yaekob Lorato Lomba.,2020)

CONCLUSION

In conclusion, artificial feeding to honeybees serves as a valuable tool in beekeeping practices, offering a means to supplement nutritional needs and support colonies during periods of natural forage scarcity. While it contributes to colony development and honey production, careful consideration must be given to the choice of feed and its impact on overall bee health.

Challenges, including the risk of nutritional imbalances and potential disease transmission, highlight the importance of informed management practices. Striking a balance between natural foraging and artificial feeding, coupled with regular monitoring, is essential for sustaining healthy honeybee populations and ensuring the resilience of these crucial pollinators in dynamic environmental conditions. Honeybee colony management encompasses a diverse array of studies and practices aimed at optimizing hive health and productivity. Various aspects of this research include hive dynamics, pest and disease control, nutrition, and environmental considerations. Studies on hive dynamics delve into factors influencing colony growth, swarming behaviour, and the intricate social structure within the hive. Effective colony management strategies often focus on understanding and responding to these natural patterns. This includes studies on the impact of artificial feeding and the formulation of optimal diets to enhance colony resilience. Environmental considerations in honeybee management encompass the effects of landscape, pesticide exposure, and climate change on bee populations. Sustainable practices that prioritize pollinator-friendly environments are increasingly emphasized. Honeybee colony management reflects a holistic approach, integrating knowledge from various disciplines to develop comprehensive strategies that balance hive health, productivity, and environmental sustainability.

REFERENCES

Abbas, T., Hasnain, A., & Ali, R. (1995). Black gram as a pollen substitute for honey bees. *Animal Feed Science and Technology*, *54*(1-4), 357-359. https://doi.org/10.1016/0377-8401(95)00772-F

Abrol, D. P. (1997). Bees and beekeeping in India. *Bees and beekeeping in India*. Ludhiana, India: Kalyani Publishers.

Akash A, Logeshkumar, Muthuraja Vikaash, Bhavanasi Satheesh, Muhilan G, Santhosh K, Kuppuraj Saravanan and Akhil S. 2025. "Scientific Beekeeping and Commercial Honey Production: A Case Study at KARE Crop Cafeteria, Krishnankovil, Tamil Nadu, India.Journal of Advances in Food Science & Technology 12 (4):1–13. https://doi.org/10.56557/jafsat/2025/v12i49713

Alaux, C., Dantec, C., Parrinello, H., & Le Conte, Y. (2011). Nutrigenomics in honey bees: digital gene expression analysis of pollen's nutritive effects on healthy and varroa-parasitized bees. *BMC Genomics*, *12*(1), 1-14. https://doi.org/10.1186/1471-2164-12-496

Aly, M. Z., Osman, K. S., Mohanny, K., & Elsayeh, W. A. (2014). New formula of pollen supplemental diets to study honey bee (Apis mellifera carnica) attractiveness. *Egyptian Academic Journal of Biological Sciences. A, Entomology*, *7*(2), 47-55. https://doi.org/10.21608/eajbsa.2014.12944

Amro, A. M. A., Omar, M., & Ahmed, A. G. (2020). *Impact of using pollen substitutes on performance of honey bee (Apis mellifera L.) colonies under harsh environmental conditions.* Science And Animal Health, 8(3), 236-256. https://doi.org/10.15210/sah.v8i3.19992

Amro, A., Younis, M., & Ghania, A. (2020). Physiological effects of some pollen substitutes diets on caged honey bee workers (Apis mellifera L.). *International Journal of Environment*, *9*(1), 87-99. https://doi.org/10.3126/ije.v9i1.27589

Araújo, G. S., Ribeiro, G. O., de Souza, S. M. A., Paulo da Silva, G., de Carvalho, G. B. M., Bispo, J. A. C., & Martínez, E. A. (2022). Rice (Oryza sativa) bran and soybean (Glycine max) meal: unconventional supplements in the mead production. Food Technology and Biotechnology, 60(1), 89-98. https://doi.org/10.17113/ftb.60.01.22.7183

Ashour, A. T., Hammad, H. M., Nour, M. E., & Zakaria, M. E. (2008). Laboratory studies of some diets as pollen substitutes on some biological activities and morphological measurements of caged worker bees at different ages. *Egyptian Journal of Agricultural Sciences*, *59*(2), 1032-10. https://doi.org/10.21608/ejarc.2008.216634

Baffoni, L., Gaggia, F., Alberoni, D., Cabbri, R., Nanetti, A., Biavati, B., & Di Gioia, D. (2016). Effect of dietary supplementation of Bifidobacterium and Lactobacillus strains in *Apis mellifera* L. against *Nosema ceranae*. *Beneficial Microbes, 7*(1), 45–51. https://doi.org/10.3920/BM2015.0085

Balkanska, R., Zhelyazkova, I., Ignatova, M., & Kashamov, B. (2013). Effect of supplementary honey and artificial sugar feeding of bees on the composition of royal jelly. Agricultural science and technology, 5(3), 335-338. https://doi.org/10.21608/ejarc.2008.216634

Barker, R. J., & Lehner, Y. (1978). Laboratory comparison of high fructose corn syrup, grape syrup, honey,

and sucrose syrup as maintenance food for caged honey bees. *Apidologie*, *9*(2), 111-116. https://www.researchgate.net/publication/257442728

Chalmers, W. T. (1980). Fish meals as pollen-protein substitutes for honeybees. *Bee world*, *61*(3), 89-96. https://doi.org/10.1080/0005772X.1980.11097784

Dalio, J. S. (2017). Foraging behaviour of honeybees on Jatropha integerrima. *Journal of Research: THE BEDE ATHENAEUM*, *8*(1), 98-101.

DeGrandi-Hoffman, G., Chen, Y., Huang, E., & Huang, M. H. (2010). The effect of diet on protein concentration, hypopharyngeal gland development and virus load in worker honey bees (Apis mellifera L.). *Journal of insect physiology*, *56*(9), 1184-1191. https://doi.org/10.1016/j.jinsphys.2010.03.017

Di Pasquale, G., Salignon, M., Le Conte, Y., Belzunces, L. P., Decourtye, A., Kretzschmar, A., & Alaux, C. (2013). Influence of pollen nutrition on honey bee health: do pollen quality and diversity matter?. PloS one, 8(8), e72016. https://doi.org/10.1371/journal.pone.0072016

Dolasevic, S., Stevanovic, J., Aleksic, N., Glavinic, U., Deletic, N., Mladenovic, M., & Stanimirovic, Z. (2020). The effect of diet types on some quality characteristics of artificially reared Apis mellifera queens. *Journal of Apicultural Research*, *59*(1), 115- 123. https://doi.org/10.1080/00218839.2019.1673965

Dr. C.U.Shinde and Prof. Kapil M. Patel (2019). *Lecture Note of Fourth Semester UG course. Ag.Ento.4.3: Management of Beneficial Insects.* 31-36. https://teachmint.storage.googleapis.com/public/709163085/StudyMaterial/677621fb-b546-4af8-8ab7-d13340e4d0e9.pdf

Farjan, M., Łopieńska-Biernat, E., Lipiński, Z., Dmitryjuk, M., & Żółtowska, K. (2014). Supplementing with vitamin C the diet of honeybees (Apis mellifera carnica) parasitized with Varroa destructor: effects on antioxidative status. *Parasitology*, *141*(6), 770-776.

Floret, V. M., & Manickavasagam, S. (2022). Effect of various sprouted pulses as pollen substitutes to manage Indian bee, *Apis cerana indica* (Hymenoptera: Apidae). *Plant Cell Biotechnology and Molecular Biology, 23*(9–10), 27–36. https://doi.org/10.56557/pcbmb/2022/v23i9-107488

Haydak, M. H., & Tanquary, M. C. (1943). Pollen and pollen substitutes in the nutrition of the honeybee. https://conservancy.umn.edu/handle/11299/176420

Höcherl, N., Siede, R., Illies, I., Gätschenberger, H., & Tautz, J. (2012). Evaluation of the nutritive value of maize for honey bees. Journal of insect physiology, 58(2), 278-285. https://doi.org/10.1016/j.jinsphys.2011.12.001

Huang, Z. (2018). Feeding honey bees. Extension Bulletin E-3369. Michigan State University. https://bees.msu.edu/wp-content/uploads/2023/08/FeedingHoneyBees-Final.pdf

Kumar, R., & Agrawal, O. P. (2014). Comparative performance of honey bee colonies fed with artificial diets in Gwalior and Panchkula region. *J. Entomol. Zool. Stud*, *2*(4), 104-107 https://www.entomoljournal.com/archives/2014/vol2issue4/PartA/2-4-104-107.pdf

Kumar, R., Rajput, G. S., & Ahmad, S. (2013). Assessment of dearth periods for honey bees (Apis mellifera) in Gwalior (MP), India. *Munis Entomology & Zoology*, *8*(2), 745-8. https://www.munisentzool.org/yayin/vol8/issue2/vol8issue2-2615473.pdf

Kumari, I., & Kumar, R. (2020). Pollen substitute diet for apis mellifera: Consumption and effects on colony parameters in sub-tropical himalaya. *Indian Journal of Agricultural Research*, *54*(2), 147-153. https://doi.org/10.18805/IJARe.5369

Lango, M. L., & Lomba, Y. L. (2020). Review on the Status of Honey Bee Feeding Practiceand Honey Production Potential: Ethiopia. https://ijrar.com/upload_issue/ijrar_issue_205.pdf

Mandal, E., Amin, M. R., Rahman, H., & Akanda, A. M. (2018). Abundance and foraging behavior of native insect pollinators and their effect on mustard (Brassica juncea L.). *Bangladesh J. Zool*, *46*(2), 117-123. https://doi.org/10.3329/bjz.v46i2.39045

Mishra, R. C. (2013). Honeybees and Their Management in India. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research. ISBN: 978-8171641475. DOI: 10.5962/bhl.title.153803

Neha, K., & Yogesh, K. (2014). Flower-visiting insect pollinators of Brown Mustard, Brassica juncea (L.) Czern and Coss and their foraging behaviour under caged and open pollination. *African Journal of Agricultural*

Research, *9*(16), 1278-1286. **DOI:** 10.5897/AJAR2014.8583

Neupane, K. R., & Thapa, R. B. (2005). Alternative to off-season sugar supplement feeding of honeybees. *Journal of the Institute of Agriculture and Animal Science*, *26*, 77-81. **DOI:** 10.3126/jiaas.v26i0.615

Ogilvie, J. E., & Forrest, J. R. (2017). Interactions between bee foraging and floral resource phenology shape bee populations and communities. *Current opinion in insect science*, *21*, 75-82. https://doi.org/10.1016/j.cois.2017.05.015

Omar, E. M., Darwish, H. Y., Othman, A. A., El-Seedi, H. R., & Al Naggar, Y. (2022). Crushing corn pollen grains increased diet digestibility and hemolymph protein content while decreasing honey bee consumption. Apidologie, 53(5), 52. https://doi.org/10.1007/s13592-022-00963-0

OSKAY, D., & Ahmet, O. Ğ. U. Z. (2022). The Effect of Substitute Feeding On Drone Larvae Production Performance in Honey Bee Colonies. *Hayvansal* Üretim, *63*(2), 84-89. https://doi.org/10.29185/hayuretim.1184151

Pande, R., & Karnatak, A. K. (2013). Utilization of temperate fruits for off-season dietary management of honey bees. *Indian Journal of Horticulture*, *70*(3), 345-349. https://doi.org/10.5958/j.0974-0112.70.3.083

Pande, R., Firake, D. M., & Karnatak, A. K. (2011). Development of pollen substitutes for dearth period management of honeybee (Apis mellifera) colonies in foothills of Shivalik range of Himalayas. Indian Journal of Agricultural Sciences, 81(9), 861. **DOI:** 10.5958/j.0974-0112.70.3.083

Paray, B. A., Kumari, I., Hajam, Y. A., Sharma, B., Kumar, R., Albeshr, M. F., ... & Khan, J. M. (2021). Honeybee nutrition and pollen substitutes: A review. *Saudi Journal of Biological Sciences*, *28*(1), 1167-1176. https://doi.org/10.1016/j.sjbs.2020.11.053

Pătruică, S., & Mot, D. (2012). The effect of using prebiotic and probiotic products on intestinal micro-flora of the honeybee (Apis mellifera carpatica). Bulletin of Entomological Research, 102(6), 619-623. https://doi.org/10.1017/S0007485312000144

Ricigliano, V. A., Mott, B. M., Floyd, A. S., Copeland, D. C., Carroll, M. J., & Anderson, K. E. (2018). Honey bees overwintering in a southern climate: longitudinal effects of nutrition and queen age on colony-level molecular physiology and performance. *Scientific Reports*, *8*(1), 10475. https://doi.org/10.1038/s41598-018-28732-z

Roy, S., Gayen, A. K., Mitra, B., & Duttagupta, A. (2014). Diversity, foraging activities of the insect visitors of Mustard (Brassica juncea Linnaeus) and their role in pollination in West Bengal. *The Journal of Zoology Studies*, *1*(2), 07-12. https://www.journalofzoology.com

Ruiz-Matute, A. I., Weiss, M., Sammataro, D., Finely, J., & Sanz, M. L. (2010). Carbohydrate composition of high-fructose corn syrups (HFCS) used for bee feeding: effect on honey composition. Journal of agricultural and food chemistry, 58(12), 7317-7322. https://doi.org/10.1021/jf100758x

Sabir, A. M., Suhail, A., Akram, W., Sarwar, G., & Saleem, M. (2000). Effect of some pollen substitute diets on the development of Apis mellifera L. colonies. *Pak. J. Biol. Sci*, *3*(5), 890-891. https://doi.org/10.3923/pjbs.2000.890.891

Shackleton, K., Balfour, N. J., Al Toufailia, H., James, E., & Ratnieks, F. L. (2023). Honey bee waggle dances facilitate shorter foraging distances and increased foraging aggregation. *Animal Behaviour*, *198*, 11-19. https://doi.org/10.1016/j.anbehav.2023.01.009

Singh, A. K., & Singh, R. P. (2012). Beneficial efeects of feeding of neem fruit pulp syrup to honey bee (Apis mellifera L.) colonies during floral dearth. Indian Journal of Entomology, 74(1), 33-35. https://www.researchgate.net/publication/309430858_Beneficial_effects_of_feeding_of_neem_fruit_pulp_syrup_to_honey_bee_Apis_mellifera_L_colonies_during_floral_dearth

Singh, R. P., & Upadhyay, S. K. (2008). The beneficial effects of feeding mahua (Bassia latifolia Roxb.) flower syrup to honey bee (Apis mellifera) colonies during periods of dearth. *Journal of apicultural research*, *47*(4), 261-264. https://doi.org/10.1080/00218839.2008.11101472

Sivaram, V. (2012). Status, prospects and strategies for development of organic beekeeping in the South Asian Countries. *Division of Apiculture and Biodiversity, Department of Botany, Bangalore University*. https://www.researchgate.net/publication/350386448_Status_prospects_and_strategies_for_development_of_organic_beekeeping_in_the_South_Asian_Countries?utm_source=chatgpt.com

Srinivasan, M. R., Kishan Tej, M., Aruna, R., & Rajadurai, G. (2015). Impact of pesticides on honey bees and pollinators. Pesticide application in agro ecosystem-its dynamics and implications. https://www.researchgate.net/publication/312654611_Impact_of_pesticides_on_honey_bees_and_pollinators

Thomas, D., Pal, N., & Rao, K. S. (2002). Bee management and productivity of Indian honeybees. *Apiacta*, *3*, 1-5.

Thomson, J. D., Forrest, J. R., & Ogilvie, J. E. (2011). Pollinator exclusion devices permitting easy access to flowers of small herbaceous plants. *Journal of Pollination Ecology*, 24-25. https://doi.org/10.26786/1920-7603(2011)11

Topal, E., Mărgăoan, R., Bay, V., Takma, Ç., Yücel, B., Oskay, D., & Kösoğlu, M. (2022). The effect of supplementary feeding with different pollens in autumn on colony development under natural environment and in vitro lifespan of honey bees. *Insects*, *13*(7), 588. https://doi.org/10.3390/insects13070588

Van der Steen, J. (2007). Effect of a home-made pollen substitute on honey bee colony development. *Journal of Apicultural Research*, *46*(2), 114-119. https://doi.org/10.1080/00218839.2007.11101377

Wheeler, M. M., & Robinson, G. E. (2014). Diet-dependent gene expression in honey bees: honey vs. sucrose or high fructose corn syrup. Scientific reports, 4(1), 5726. https://doi.org/10.1038/srep05726