# 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 major role in increasing the income of farmers **(Yogesh Kumar,2014)**. In India mostly, *Apis cerana* and *Apis Melifera* are reared for their high honey production and less swarming. *Apis melifera* is mostly 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 couldmanaged by the honeybees through 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 bee foraging of honeybees. 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 the foraging is 15 km by A.*mellifera* and 21.8 km travelled by A. *dorsata* **(kyle Shacleton et al.,2023)** During the dearth period, honey bees were fed with artificial feeding to increase honey production **(M. Kishan Tej.,2015).** Honeybees intake nutrients from pollen during bee foraging **(J van der steen,2007).** Honeybees feed on the source that contains proteins, carbohydrates, lipids, and other micronutrients. High nutritional content source is mostly preferred by honeybees **(Erkan Topal.et.al.,2022).**

## BEE FLORA

Honeybees majorly depend on the nectar and pollen of the flowers for their growth and development. Bee flora differs from area to area and bee foraging depends on the availability of the flowers available near the apiary. The pollen was collected from various plants to satisfy its nutritional needs. **(Jasvir Singh Dalio.,2022).** The major 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 major pollen sources of bee flora are Rice *(Oryza sativa)*, Horse gram *(Dolichos biflorus),* Green Gram (Vigna radiata), Chilli *(Capsicum annum),* Capsicum (*Capsicum chinense)* in vegetables 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 throughout the year. The honey flow period depends on the flora attributes such as blooming season, flowering period length, attractiveness of the flowering, 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 was increased it causes 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 mostly face a major 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 fed 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 important roles of protein 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 depends 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 major 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. At 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 which could help the bees from 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 bee hive and a hole is made in the plastic bag for easy access to the honey bees. To prevent the squishing of the bag, a rim is put underneath the inner cover.

## Barrel feeding

The barrel feeding method is used in maintaining of higher number of colonies. The barrel is placed in the yard. An ample amount of the 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 boiled potable water is used **(Erkan Topal.et.al.,2022).** For artificial feeding Sugar Syrup is made by mixing 200g of Sugar and 20g of honey in 1 Liter of water which contains high glucose. The result in 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 ratio of making the sugar syrup is a 1:1 ratio of sugar and water which would help in the increase of nutrient content in the honey bees **(Zachary Huang.,2018).** The study analyzed 29 royal jelly samples from May to August 2012, comparing the composition of bees fed with 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 4hrs which was filtered in 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 physiochemically characterized. The fermentation of three yeasts (Saccharomyces bayanus Premier Blanc, Saccharomyces cerevisiae Montrachet, and Saccharomyces cerevisiae Safbrew T-

58) in honey was tested with 30 g/L rice bran or soybean meal extracts. The studies compared to 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 was filtered in muslin cloth. Filtered 1 litre 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, the process glucose isomerase used to convert the glucose from hydrolyzed corn starch which the mixture contains 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, 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 deficiencies. 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 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 sugar and 20g honey. The honeybees utilized 99.5% pumpkin syrup and 96.7% banana syrup with the result of 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, so fructose is called ‘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 result from the feeding of different types of syrup shows the various levels of sugar contents **(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.) which resulted in the consumption and acceptance of the honeybee colonies were 100% and 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 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 is added and blended. With this mixture add 100ml of water and 50g skim milk powder and make it a smooth dough where the result from this box is 7.12kg of honey **(Tahir Abbas.*et.al.,*1995).** The experimental study explained that feeding of soy Flour (16.7%) + Parched Gram (16.7%) + Brewer’s Yeast (16.7%) +Sugar (33.3%) + 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, effective 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 insufficient pollen availability and diversity **(Saboor Ahmad.et.al.,2021).**

## PULSES SYRUP

Black gram flour of 550g is added with 250g of sugar and 50g of yeast is blended. With this mixture 100ml of water and 50g skim milk powder is added and made into smooth dough where the result from the box is 8.62kg within 3 months of period. They also observed an increase in the number of frames for honey production **(Tahir Abbas.*et.al.,*1995).** As artificial feeding Chickpeas, green gram, germinated horse gram and germinated pea were ground into flour and fed as the artificial feeding for the honeybees. 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 flour. 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 over 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. In which we have to dilute protein level 23% which is suitable for the broods. It contains high 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, increased number of bee strength has increased in the colonies **(Rajesh Kumar.et.al.,2013).** Liquid yeast (Candida tropicalis) + 750ml of water + 1000g of sugar which provides the lowest number of queen colonies.1000g of Sugar + 250 g of dried brewer’s yeast (Sccharomyces sp.) + 750ml of water is a mixture for the artificial feeding. The result during the process is colonies were developed with an increased number of brood chambers **(Azza. T. Ashour.,2008).** Bee disease is a major 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 and 20ml of water are added and made into the paste. Again, the mixture was added to the 200g of honey and ground in the mortar. Cotton seed meal and dry skim milk at the ratio of 4:1 and 40g of the mixture is added with 200g of honey and 20 ml of water is ground with mortar **(MYKOLA H. Haydak.,1939).**In bee colonies, protein flow was maintained by the artificial feeding of pollen in fluctuation time. The components for making artificial feeding of pollen are soya flour, beer yeast of 3 parts, calcium caseinate flour and whey protein flour of 3.2 parts, sucrose solution 50% and 10 parts of linseed oil **(J van der 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 + Soybean flour **(Oskay.D.,2021).** C. *creticus*(Pink rock-rose) pollen

+ Sugar Syrup + Water, P. *somniferum* (Opium Poppy) pollen + Sugar Syrup + Water, Mixed Pollen + Sugar syrup +Water, Commercial Bee Cake + Sugar Syrup + Waterwere fed as the artificial feeding for the 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 the 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 with artificial feeding such as sugar syrup and pollen to the queen bees. The result was observed in the queen bees at the colony by the increased size of the queen cells, length and weight of the queen cells were increased **(Slobodan Dolasevic.et.al.,2019).** Honeybees were fed with sugar and water at the ratio of 3:1 and in addition vitamin C (Bio factor, Poland) at the rate of 1.8 mg per 1kg syrup. As the result of artificial feeding of vitamin C, the weight of the honeybee larvae was 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 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 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.

**REFERENCE**

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.

Abrol, D. P. (1997). Bees and beekeeping in India. *Bees and beekeeping in India.*

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.

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.

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.

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.

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.

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.

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.

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.

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.

Chalmers, W. T. (1980). Fish meals as pollen-protein substitutes for honeybees. *Bee world*, *61*(3), 89-96.

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.

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.

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.

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.

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, 27-36.

Haydak, M. H., & Tanquary, M. C. (1943). Pollen and pollen substitutes in the nutrition of the honeybee.

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:/[/www.ontariobee.com/sit](http://www.ontariobee.com/sites/ontariobee.com/files/GuideFeedingBees.pdf)e[s/ontariobee.com/files/GuideFeedingBees.pdf](http://www.ontariobee.com/sites/ontariobee.com/files/GuideFeedingBees.pdf)

Huang, Z. (2018). Feeding honey bees. Extension Bulletin E-3369. Michigan State University.

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

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.

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.

Lango, M. L., & Lomba, Y. L. (2020). Review on the Status of Honey Bee Feeding Practiceand Honey Production Potential: Ethiopia.

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.

Mishra, R. C. (1995). Honeybees and their management in India. *Honeybees and their management in India.*

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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*.

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.

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.

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.

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.

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.