Ministry of Food Processing Industries
Government of India

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Reading Manual for Honey
Under PMFME Scheme

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Contents

Abbreviations & Acronyms

Sr:No.	Abbreviations &Acronyms	Full Forms
1.	PM FME	Prime Minister's Formalisation of Micro Food Processing Enterprises Scheme
2.	PET	Polyethylene terephthalate
3.	PA	Polyamide
4.	PE	Poly Ethylene
5.	HACCP	Hazard Analysis and Critical Control Point
6.	GAP	Good Agricultural Practices
7.	GMP	Good Manufacturing Practice
8.	SOP	Standard operating procedure
9.	FSSAI	Food Safety and Standards Authority of India
10.	FoSCos	Food Safety Compliance System
11.	FBO	Food Business Operator
12.	FLRS	Food Licensing and Registration System
13.	FSS	Food Set and Sound Nutrition
14.	PFA	Prevention of Food Adulteration
15.	GST	Goods and Services Tax
16.	MoFPI	Ministry of Food Processing Industries
17.	FPOs	Farmer Producer Organizations
18.	SHGs	Self Help Groups

CHAPTER- 1

INTRODUCTION ON PROCESSING

1.1 Industrial Overview

Honey is a stuff used as food and medical from ancient times to the present day. It has various useful pharmacological effects as antimicrobial, anti-inflammatory, antimutagenic, antioxidant and prebiotic properties. The favonoids, phenolic acids, organic acids, enzymes, and other minor components provide antioxidant property for honey (Bogdanov., 1997, Gheldof et al., 2002., Kucuk et al., 2007). The composition and antioxidant activity of honey depend on the floral sources, seasonal and environmental factors, processing methods and storage conditions (Al-Mamary 2002., Akhmazillah, 2013).

There are two agencies that are forming the standards at International Level and these are

a. **The Codex standard for honey** adopted by the Codex Alimentarius Commission in 1981, revised in 1987 and 2001, has voluntary application and serves in many cases as a basis for national legislation (Codex, 2001).
b. **The European Council followed the recommendations of Codex, and issued Directive 2001/110/EC (EC, 2001), amended 2014/63/EU (EU, 2014)** that laid down the production and trading parameters of honey within the Member States of the EU (EU, 2011, 2014).

At the National Level, standards of honey are formed by FSSAI.

FSSAI has notified the Food Safety and Standards (Food Products Standards and Food Additives) ninth Amendment Regulations, 2018. The amendment regulations prescribe revised standards of Honey.

DEFINITION OF HONEY:

According to the Codex standard for honey adopted by the Codex Alimentarius Commission in 1981, revised in 1987 and 2001,, amended in 2019., Honey is the natural sweet substance produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature.

According to FSSAI, Honey is the natural sweet substance produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature.

Directive 2001/110/EC (EC, 2001), amended 2014/63/EU (EU, 2014) defines honey as “the natural sweet substance produced by *Apis mellifera* bees

So differentiating the *Apis* *mellifera* honey from that is produced by other species of bees like Micrapis, Megapis and Meliponines which is not being done by Codex and FSSAI.

1.2 Categories of Honey

- **Monofloral honey** is where the bees have been foraging predominantly on one type of plant, and is named according to that plant. (> 45% pollen from one plant). Few examples are
    - Thyme Honey
    - Jamun Honey
    - Acacia Honey
    - Lychee Honey
    - Clover Honey
    - Ajwain Honey
    - Acacia Honey
    - Buckwheat Honey
    - Clover Honey
    - Dandelion Honey
    - Clover Honey
    - Heather Honey
    - Lavender Honey
    - Orange Blossom Honey

Uni-floral honey's price is always several times higher than multi-floral honey, this is because, the dominant blossom's nectar and pollen determine the taste, flavor and properties. The premium quality of unifloral honey also depends upon geographical area and plant species e.g. Manuka honey from New Zealand. Unifloral honey is the result of two conditions. First, the target plant must predominate so the bees have little choice of plants. Second, the beekeeper must time the introduction of the hive and the actual harvesting of the comb to coincide with this blooming period. This is done by carefully observing the blooming period of the chosen plant as well as possible overlapping blooming periods of other nectar-producing plants as well.

Proportions of flowers are usually determined by the percentage of its pollen in the honey. Pollen tends to be unique for each species of plant and can be identified and counted. Since different flowers have more or less pollen, there are often different pollen content requirements. A pollen percentage of 45% or better is common but it can be as low as 15% for certain types of single flower honeys that have low pollen counts (such as Lavender). This percentage is often set by the country of origin for more common single flower honeys such as Acacia .

The main unifloral honey produced in the EU is acacia honey,as the black locust tree from which it is obtained is widelyspread in Europe. The main producers of acacia honey in Europe are Hungary, Bulgaria and Romania, although it is also produced in other EU countries. Other types of unifloralhoney commonly produced in the EU are: rapeseed, sunflower,linden blossom, heather, lavender, rosemary, thyme, orange blossom, chestnut and forest honey (Seijo et al., 1997; Serra, 1989; Serra and Ventura., 1995).

Multifloral Honey (also known as polyfloral) has several botanical sources, none of which is predominant (<45% pollen from one plant). This definition should not be seen as a lack of identity or minor quality. There is not only one single type of multifloral honey because there are endless possible floral combinations which may exist in honey. Every kind of multifloral honey has its own specific features that repeat themselves year after year with a smaller or greater degree of variability. However its basic distinctive features are always recognizable.

Sometimes multiflower honey is made of a dominant plant species that makes up its core but which is not enough to define it as monofloral but at the same time it is not always accompanied by a constant concurrent flora (Abdulkhaliq & Swaileh, 2016).

1.3 Designation of Honey according to production

Extracted honey is the most basic and widespread hive product. It is obtained by centrifuging decapped broodless combs. Honey extraction is the central practice of removing honey from honeycomb so that it is isolated in a pure liquid form.The honey is stored by honey bees in their beeswax honeycomb (Bogdanov, 2009).

Pressed Honey is honey obtained by pressing brood less combs with or without the application of moderate heat. Although this is more complex but also more gentle than the usual spinning. Pressed honey has a very intense aroma and contains a lot of flower pollen (Bogdanov ,2009).

Drained Honey is honey obtained by draining decapped broodless combs (Bogdanov, 2009).

Honey may be designated according to the following styles according to the processing procedure:

COMB HONEY

Comb Honey which is honey stored by bees in the cells of freshly built broodless combs and which is sold in sealed whole combs or sections of such combs (Bogdanov,2009).

CHUNK HONEY

Chunk Honey which is honey containing one or more pieces of comb honey (Bogdanov, 2009).

CREAMED HONEY

Creamed (or creamy or set) Honey is honey which has a fine crystalline structure and which may have undergone a physical process to give it that structure and to make it easy to spread (Bogdanov, 2009).

1.4 Other Category

Organic Honey

Organic honey is produced by apiaries with certified organic beekeeping. The composition of organic honey is the same as normal natural honey. The only difference is that such honey should not contain toxic residues of pesticides used in agriculture and beekeeping.

1.5 Honey Production and Export From India

As per the latest data from the **National Bee Board**, under the Department of Agriculture, the country's total honey production reported in 2017 – 2018 was 1.05 lakh metric tonnes (MTs), compared to the 35,000 metric tonnes in 2005-2006. Today, India also has as many as 35 lakh bee colonies, compared to 8 lakh during 2005-2006. The number of beekeepers, beekeeping companies and honey societies has also increased and as of January 2019, the country had 9,091 registered people in the apiary business. The total numbers of beekeepers are 2 lakh. While the per capita honey consumption is as low as 50 grams per year in India, globally it ranges from 250 to 300 grams, with Germany topping in per capita honey consumption, with a whopping 2 kg per year. In Asia, Japan is the biggest consumer of honey, with per capita consumption of up to 700 grams per year.

Alongside production of honey, exports have also increased in recent years, with Germany, US, UK, Japan, France, Spain and Italy being the main markets. India, during 2017 – 2018, exported a total of 51,547 (MTs) whereas the exports were 16,769 MTs during 2005 – 2006 **(National Bee Board, 2017-18).**

1.6 Honey Processing

Harvesting and Transport of Raw Honey

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Liquefaction of Granulated Honey

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Straining

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Filtration

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Moisture Reduction

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Pasteurization

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Cooling

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Bottling

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Labeling

Figure: 1 Flow Diagram of Honey Processing

1.6.1 Harvesting and Transport of Raw Honey

The some procedures for harvesting and transport of honey must be followed, so that there should be efficient collection, to maintain its original characteristics and composition, hence its quality.

In rainy days or when the relative humidity is high, harvest of honey is not recommended, because this would lead to increased moisture content in the honey. When harvesting, care should be taken not to throw smoke directly on the honeycombs; this should be performed at small amounts, by using the bee smoker far away from the frames of honeycombs. These procedures are followed so that there is reduction of the incorporation of the smoke able smell into honey.

Honeycombs that are at least two-thirds capped are uncapped using a long-handled uncapping fork, the beekeeper scrapes the caps from both sides of the honeycomb onto a capping tray.

The honeycombs are inserted into an extractor, a large drum that employs centrifugal force to draw out the honey. The extractor is started at a slow speed to prevent the breaking of combs.

As the extractor spins, the honey is pulled out and up against the walls. It drips down to the cone-shaped bottom and out of the extractor through a spigot. Positioned under the spigot is a honey bucket topped by two sieves, one coarse and one fine, to hold back wax particles and other debris. The honey is poured into food grade plastic buckets or drums and taken to the Industrial processor.

The vehicle used in transporting the honey to the processing area must be subjected to a hygienic process. It is necessary that the vehicle did not recently transport any material that might have left some type of toxic residue, or otherwise has strong odor. Long distance transport and keeping the honey buckets in open before processing may lead to the deterioration in quality as it may lead to increase in the hydromethyl furfural and decrease in Diastase activity (Gebrehiwot, 2015).

1.6.2 Liquefaction of granulated Honey:

Honey crystallization or granulation is a natural phenomenon by which honey turns from liquid (runny) state to a semi-solid state. Crystallization of honey is neither the adulteration of honey with sugar nor it is an unnatural product. Most pure raw or unheated honey has a natural tendency to crystallize over time. Crystallization does not affect the honey except for colour and texture. Crystallized honey is not spoiled and preserves the flavour and quality characteristics of the liquid honey.

Some honeys crystallize uniformly; some will be partially crystallized and form two layers, with the crystallized layer on the bottom of the jar and a liquid on top. Honeys also vary in the size of the crystals formed. Some form fine crystals and others large, gritty ones. The more rapid honey crystallizes, the finer the texture will be. Crystallized honey tends to set a lighter/paler colour than when liquid. This is due to the fact that glucose sugar tends to separate out in dehydrating crystals form, and that glucose crystals are naturally pure white. Darker honeys retain a brownish appearance.

Heating is the most widely used processing method in the honey because of granulation, high viscosity at low temperature and existence of yeast. According to the various honey regulations, it is forbidden to heat honey as it impairs its quality significantly. Therefore, honey should be liquefied in such a way as to avoid heat damage to its various constituents. The liquefaction time depends on the glucose concentration: the higher the glucose content and the larger the crystals, the longer the liquefaction time. Heating should be applied indirectly, not by direct flame to a container. Heating at higher temperatures of for a longer period of time will cause honey damage, development of hydroxymethylfurfural, loss of diastase, decrease of aroma and in extreme cases building of a caramel like taste because of maillard reaction . Overheating is determined most easily by the measurement of hydroxymethyl furfural (HMF) and honey enzyme activity. Honey should be heated with care to prevent overheating.

1.6.3 Heating by water bath:

a) This is best for the batch process and also from point of optimal heat transfer. The care should be taken that temperature should not go beyond 40^{o}C to 45^{o}C. The time required will depend upon amount of honey taken, the extent of granulation and kind of honey. Stir occasionally to even the heat throughout the honey, as crystallized honey is a poor conductor of heat. It is a lengthy process and may take several hours. There are only few commercially available heating water bath systems.

b) Honey can be liquefied by using the double jacketed vat. Hot water was circulated in a water jacket around the honey container to heat honey. The temperature of the circulated water should be maintained in such a way that maximum temperature of honey should be around 45^{o}C.

c) **Immersion heaters** can be placed on the granulated honey, which progressively sink upon honey melting. This high-quality food-grade stainless steel immersion heater can be used. Simply hang the heater on the top of the honey drum with the heat coils resting on the inside of the tank. The temperature controller is also there and a heat range from 30^{o}C to 80 ^{o}C can be adjusted.

d) Honey can be liquefied by placing the vessels on **electric plates or directly placed on the wood fire**. Although an air gap is maintained between the electric plates or the wood fire and the honey drum, but still it is a kind of direct heating of honey and is **not recommended**. This type of heating is widely used by small beekeepers.

1.6.4 Straining and Filteration

According to Codex, Honey which has been filtered in such a way as to result in the significant removal of pollen shall be designated filtered honey.

According to European Directive, filtered honey is obtained by removing foreign inorganic or organic matter in such a way as to result in the significant removal of pollen. According to USDA Grading Standards for extracted honey, filtered honey is honey that has been filtered to the extent that all or most of the fine particles, pollen grains, air bubbles, and other materials normally found in suspension have been removed.

1.6.5 Straining

The straining operation to remove suspended solids (including large wax particles) is carried out either manually or by mechanical means. The method and the equipment used for straining depend on the size of the operation. In small-scale operations, straining is done using cloth or nylon bags, which are frequently cleaned to remove the suspended particles.

In large-scale operations, the straining operation is combined with the preheating (up to 40°C) operation in a jacketed tank fitted with a stirrer.

1.6.6 Filteration

The strained honey is further processed using pressure filters. Typically a polypropylene micro filter of 80 μm is used as a filter medium. The honey temperature is maintained between 50–

55°C, which prevents the melting of the beeswax. Large-scale processors subject honey to coarse filtration, centrifugal clarification, fine filtration, and blending, prior to filling.

The filtration should be done carefully so that required pollen count in the honey must be retained. The various types of filtration units which are available are filter press, sparkle filters etc.

Filter Press

Moisture Reduction

Reason To Reduce Moisture Content In Honey

Moisture is one of the most important parameter of honey quality. Most of the extracted honeys are having the higher moisture than the prescribed standards because of extraction of unripened honey. The amount of water present in honey determines its stability against fermentation and granulation .Honey having high water content ferments easily with time. So, it is necessary to process the honey by subjecting it to thermal treatment to prevent fermentation by sugar tolerant yeasts. Treatment in a closed system minimizes losses of volatile aroma during heating. The honey streams help in increasing the exposed surface area of honey in contact with drying air.

Wakhle et al. (1996) developed a honey moisture reduction unit which consisted of falling film evaporator. In this multiple effect evaporation system, raw honey was preheated (40–45 °C) and then filtered through 80 lm polypropylene micro-filter. This honey was heated up to 60–65 °C in first effect to destroy osmo-phillic yeast cells, held at 60°C for evaporation of water under vacuum and Then cooled in third effect before passing into settling tanks for bottling. The system had a capacity of processing 300 kg of honey per day.

Equipment consisted of a closed housing with an inlet port on the top side and an outlet port on the bottom edge. The honey will enter the inlet port and flows downward across a series of trays arranged in a zigzagged manner up to the outlet port. A metal screen is used on each tray to spread the honey evenly throughout the tray. There is a coil and an evaporator heater used to dry and warm the air circulated over the honey layer to remove moisture. This process claimed in reduced honey's water content from 20 % to 18.5% with an airflow rate around 28 m^3/min. and a temperature used around 49°C

1.6.7 Pasteurization of Honey

Honey can be consumed pasteurized or not. Honey is low in humidity and high in acidity, which means that bacteria cannot survive in it. Honey is pasteurized for quality reasons. Pasteurization of honey reduces the chance of fermentation and also delays granulation. Different Temperature and Time combinations are suggested. Heating the honey to 63°C for 30 minutes or 65.5°C for 30 minutes or temperature be brought to 77° C momentarily and followed by the rapid cooling.

Problem of *Clostridium Botulinum* in Honey

Very Young children or those with compromised immune systems should consume only pasteurized honey. This is because there are a small number of cases each year where spores of *Clostridium botulinum* found in honey have been responsible for botulism poisoning. According to the U.S. National Library of Medicine, approximately 110 cases of botulism poisoning occur each year in the United States, mostly from improperly canned food, corn syrup, and honey. About 90% of these cases occur in children under six months old. Although the spores of *Clostridium botulinum* cannot grow or make toxin in the acidic environment of honey, they survive in a resting state. If they are eaten by an infant, the spores can grow, reproduce, and make toxins while living in the baby's intestinal tract. The toxins are then absorbed into the child's body and can cause illness. Both the actual *Clostridium botulinum* bacteria and the toxins it produces are easily destroyed by boiling for several minutes or by holding them at lower temperatures for longer times. The spores, on the other hand, are extremely resistant. Pressure cooking at 250°F (121° C) for three minutes will kill the spores, as will other combinations of temperature, pressure, time, and acidity. The common honey pasteurization process is much less rigorous and could not possibly kill the spores responsible for infant botulism. (Küplülü, etal., 2006; Gücükoğlu et al., 2014)

1.6.8 Bottling

Depending on the market requirement, honey may be bottled directly into small containers for retail sale or into large drums for storage or export to another countries. In an effort to appeal to a wide range of consumers, honey is packaged in containers of many different sizes and styles. These include glass, plastic containers, honey tubs, or even squeeze bottles, Like most aspects of honey processing, bottling can involve automation in large operations, or manual labour such as a hand valve on a plastic pail in smaller operations. Presence of air bubbles in the packaging containers can provoke nucleation and crystallization of honey. The filling of honey in the bottles is normally done at the high temperature. Filling at higher temperatures eliminates air bubbles and avoids air incorporation during packing due to low viscosity.

1.6.9 Labelling

The label on a honey container in a retail outlet should include the word "Honey" or, possibly, an indication of a floral source, such as “Mustard Honey.“ It also needs to state the net weight, the name and address of the honey dealer and the FSSAI registration number of the packer, as well as the nutrition facts table. The label should also identify the country of origin and indicate whether the honey is creamed, liquid or pasteurized. Honey sold at a Apiary or farmers' market does not need to meet the same labelling requirements because it's usually coming directly from the producer.

CHAPTER - 2

INTRODUCTION ON PACKAGING

A recent rise in functional foods and products improving the immunity, the demand of honey - a nutritious food that must be correctly packaged to obtain a safe product, has increased rapidly from past few years. However, before selling, honey needs to meet several quality requirements and then supplied to the customer with its basic composition and quality minimally changed with regard to freshly harvested honey (Codex, 2001). Several international and sometimes national laws define the standard of honey (European Union, 2002; FSSAI, 2020a). Therefore, the packaging industry must conduct a wide range of examinations, such as pollen count and physicochemical parameters like hydroxymethylfurfural - HMF, moisture, and color, on obtaining lots of raw honey. Two key explanations for this include: (1) promotion of classification of the botanical sources of honeys (considering its pollen percentage and colour) and (2) compliance with the required mandatory standards during sales (i.e. HMF content less than 80 mg/kg, or moisture content less than 20 g/100 g) (FSSAI, 2020a).

Unifloral honey still has a higher commercial value than polyfloral honey. Therefore, honey must be tested for botanical origin in the packaging industry. The microscopic examination for identification and quantification of proportion of pollen is used to validate botanical origin of honey (Escriche et al., 2012; Panseri et al., 2013). Honey colour is specifically correlated with the nectar's botanical source and thus may contribute to the classification of unifloral honeys. Moreover, the commercial value of this parameter is used as a criterion for customer acceptance or refusal. HMF is another most consistent measure of honey freshness since in freshly harvested honey, it is virtually absent (Khalil et al., 2010). It increases however during handling, extraction, conditioning or storage operations and as a result of liquefaction and pasteurization to enhance its management and to destroy the crystallization (Visquert et al., 2014). Honey packaging plants therefore, need to be very cautious about the HMF content of raw honey, as they are allowed by regulation, on the best before-date printed on the label, to fulfil the requirement of this parameter (Juan-Borrás et al., 2015).The honey moisture depends on the season it is harvested, the environment and the good practises of beekeepers (Oddo et al., 2004). This parameter is crucial to viscosity, palatability and flavor but in general to crystallisation and fermentation (Turhan et al., 2008). Both changes alter the appearance and thereby contribute to the refusal of consumers, which leads in losses to the industry.

Honey's shelf life is largely determined by packaging that must protect the honey from environmental effects externally. The degradation of packaged honey primarily depends on transfers between the external environment exposed to storage and delivery hazards and the internal package environment. Honey may be directly bottled into small retail containers or into large drums for storage or export, depending on the intended market. Honey is packaged in containers of several different sizes and shapes in an attempt to cater the vast variety of customers. The glass jar, followed by plastic jar or tub/drums (in case of large quantity) and squeezable jugs or bottles are the most common ways to pack honey (Postacchini et al., 2018).**Fig. 1** shows different containers used for packing honey during collection, processing and storage in addition to creative shapes of bottles/jars used in retail outlets.

Fig. 1 Different packaging materialsused duringthe supply chain of honey

2.1 Overview of Packaging

'Packaging' is an art, science, and technology, aiming to ensure quality, wholesomeness, integrity and safety of a product. It serves as a means to ensure safe delivery of food products to a consumer, including a techno-commercial function aimed to optimize delivery costs whilst maximizing sales (Emblem, 2012). The major functions of packaging are illustrated in **Fig. 2**. Food like honeymaycome in contact with physical, chemical and biological agents during handling, preparation or transportation, but packaging facilitates to retain its goodness and freshness. Thus, packaging must serve as the protection or barrier layer from contamination, external environment and mechanical damage during transport. It further avoids the scope of contamination that can arise when kept in contact with other food products at any point of the food supply chain (Robertson, 2016). Today's market alsodemands a range of requirements and specifications for food packaging as well as labeling.Importantly, food packaging serves as an identification and communication tool between the producer and consumer, presenting details of the product such as nutritional facts, health benefits, direction to use and store, place of manufacture, manufacture date, expiry date/best before date and other relevant information (Wyrwa and Barska, 2017).

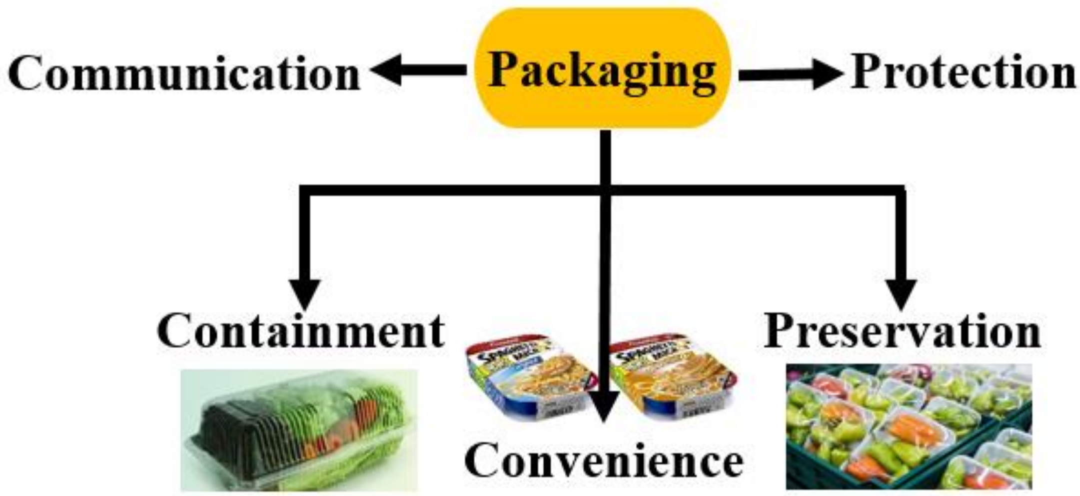

Fig. 2 Summary of functions of food packaging systems

The packaging of honey mainly focuses on product safety. But, if the packaging or package itself is not reliable, the safety becomes a matter of concern (Juan-Borrás et al., 2015). In case of honey, the predominant factors that decide the quality, safety and shelf-life include: temperature, relative humidity and moisture content. Innovative packaging therefore must meet the development of various novel packaging techniques and advanced inter-disciplinary applications.

Packaging of honey requires their own specific packaging materials as per the usages. Storage containers for honey should be made either of glass, plastic, and stainless steel or metal coated with food approved plastic, paint or beeswax to make air tight (Martínez et al., 2018). All packages must be odorless, no exposed metal which will react with honey. The container must facilitate easy removal of honey. The label, container shape and material or other material should choose accordingly. Recycled glass bottles may be appropriate if they can be cleaned adequately and a cork type seal can be provided. Package choice should however also consider recyclability, disposability and environmentally friendly manufacturing of the packaging materials (Gutta and Kuriger, 2013; Klaiman et al., 2016). For most retailing of pure honey, the preferred packaging material is glass followed by plastic or, for large quantities, metal container coated with materials appropriate for contact with acidic food like honey, whereas LDPE (low density polyethylene) and HDPE (high density polyethylene) based large plastic buckets are preferred for transportation and distribution of raw honey. Screw top lids on glass jars are most secure and preferred (Postacchini et al., 2018). Heat-sealed plastic and aluminum lids on plastic cups are fairly safe as well.

The bottle/jar or container should be leak-proof and airtight so as to safely contain the honey which must present the honey in an attractive form, enticing the consumer to buy it. The label, container shape and material should be chosen accordingly. These days, honey packaging varies in different attracting design with the creative sense which may combine with wood in their bottle cap (Ksenia, 2013; Yang and Hsu, 2020). The decision about which form of presentation or packaging to choose for marketing should take into consideration the predominant local form of use, the honey characteristics (such as crystallization, fermentation and colour) the volume, the length of time between processing, retailing and consumption, the availability and cost of filling technologies and packaging materials, the potential appeal to the consumers and the environmental compatibility of materials (Roman et al., 2013; Juan-Borrás et al., 2015).

2.2 Glass as Packaging Material

With its odourless, chemically inert ability and impermeability to gases and water vapours, glass has an enormously long history in food packaging. Glass packaging guarantees a practically absolute barrier to the use of chemical and other toxic agents and a ideal chemical protection to save food from alterations induced by exposure to gases and moisture. Plastic packaging has strong properties but is typically less effective compared to glass packaging compared to chemical and biological factors (Marsh and Bugusu, 2007).

Commercial glass is manufactured in advanced furnaces that produce very high processing temperatures (1350–1600 °C). Before being fed, the major ingredients like silica/sand, soda ash and limestone are weighed and mixed. The complete flow chart for production of glass bottle is given in **Fig. 3**. The mixed ingredients are heated and impurities are risen to the molten glass surface. The forehearth reduces temperature to 1100°C and molten glass achieved the consistency, to feed to the bottle-forming machines by means of a gravitational drop. Molten glass passes through the draw-off spouts of 12 to 50 mm wide orifices, as per the size of container. The 'gobs' of molten glass are cut using a water-cooled mechanical shear under the orifice, synchronized with the draw-off flux speed and bottle-forming unit. Gob is used to make a single container. Glass containers are manufactured using three different processes, depending on their geometry: (i) blow-and-blow (ii) press-and-blow (iii) narrow neck press-and-blow (Grayhurst, 2012).

Two moulds (made of cast iron) are required for processes: (i) a blank mould forming an initial shape and (ii) a blow-mould creating the final shape. The method is based on the fact that the glass is sufficiently warm and flexible. The temperature is approximately 450°C when the bottles leave the mould. The low thermal conductivity of glass would cool inside more slowly than the outside if containers were left to cool off on their own. This would contribute to uneven cooling and stress in the container walls. To avoid this, the containers are moved to a annealing oven, called a 'lehr' - a belt which slowly crosses a long oven of 30 m (Hann, 2013). At first, the temperature of glass is increased to 540-570°C to alleviate stress and then gradually cooled to reduce stress until the containers are found at around 60°C. Until packaging, they will cool down further for smoother surfaces but scraping on the surface can take place when the bottles rub together in high-speed filling lines.Scratched glass is considerably less resistant to break and so, in order to minimise this issue, containers are typically coated with tin or titanium tetrachloride or a friction reduced coat of various formulations, including oleic acid, monostearates, waxes, silicones and polyethylene (Pantano, 2009).

In terms of appearance and attractiveness, there is no competition between plastic and glass bottles, however, packing honey in glass bottles/jars would definitely make it look premium and classy and dramatically improves the chances to purchase or prefer something better and more appealing in everyone's subconsciousness. Square and round glass bottles are commonly found in honey market. Furthermore, glass transparency helps the product to be clearly viewed, ensuring that all aspects are fine with the product. Honey in the glass jar is therefore the perfect worldwide packaging practise. Honey should be stored in containers that are airtight because it helps to preserve the honey water content. Honey crystallises faster if water is permitted to evaporate.Honey is highly likely to ferment if absorb the water. It will not ferment if its water content is below 17.10% (Subramanian et al., 2007; Singh and Singh, 2018). The high gas and moisture barrier properties in glass bottles/jars prevent interaction between air, moisture and fluids, and therefore, packing honey in glass container is the right option.

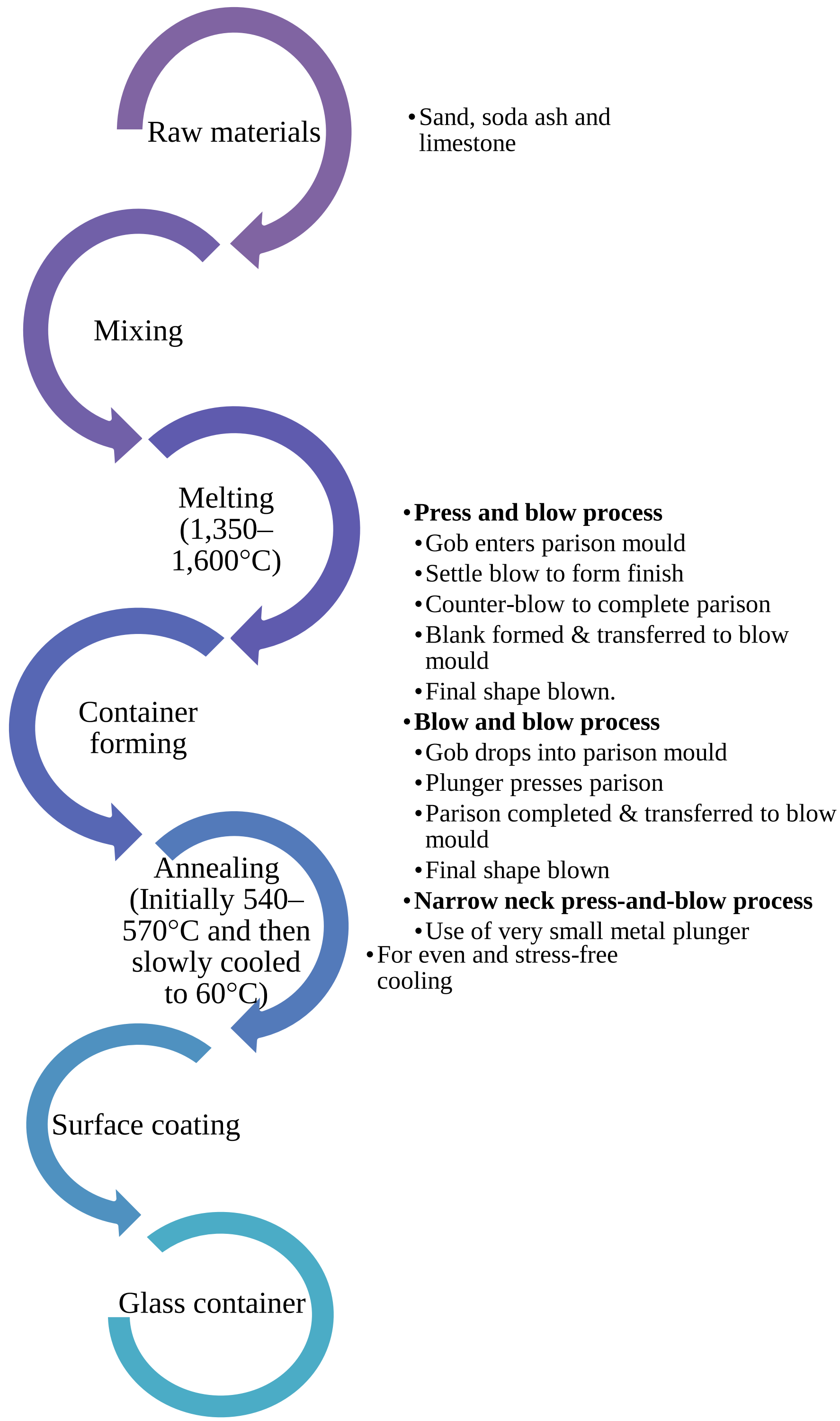

Fig. 3 Process flow diagram of glass manufacturing (Grayhurst, 2012)

Nevertheless, bottles containing any oils, homemade cleaners or other non-food or non-drinkable liquid previously should never be used. Bottles need to be rinsed several times if they are washed with soap. If water is limited, sand and clean soap should be used to wash the bottles. Most bottles' screw tops are not very close and the ants invade such bottles frequently. Corks or wooden taps that are not hermetically sealed must be sealed with warm beeswax. While an original logo and label can eventually convey the brand, the choice of wrong packaging material will make the brand dull. Therefore the choice of packaging material like glass bottles or jars is of paramount importance.

2.3 Plastic as Packaging Material

In real-life, the plastic as packaging material is almost non-breakable, safer to handle and avoid any kind of injury to product. It is much lighter and long-lasting than glass and makes transportation cheaper. Moreover, plastic is versatile than glass to make it easier to shape and make identity building for brands. While they are not as appealing as clear glass jars, plastics are cheaper and easier to ship and store in stackable cup or jar form (Andrady and Neal, 2009; Balzarotti et al., 2015). Top lids are normally screwed on plastic jars and contribute to sticky containers when being transported resulting in loss of honey and its spoilage. This problem however can be solved by the heat-sealed inner lids or plastic films used in many pharmaceutical or medical bottles.

Honey is typically packaged in plastic bottles or jars, made of polyethylene terephthalate (PET) which are airtight, leak resistant, non-breakable, without odours, and long lasting ((Martínez et al., 2018). If ethylene glycol reacts with terephthalic acid and polymeris, the end product is PET. PET is a thermoplastic polymer that is linear and translucent. PET bottles with small crystallites and outstanding transparency are primarily amorphous. PET bottles have a high tensile strength, strong chemical resistance, light weight and elasticity as a food-packaging material. It has low moisture and gas permeability, but a bad sealing property (Pergal and Balaban, 2017). Therefore, PET must be laminated with PE. PET melts at a temperature much higher than PP, usually 260 °C. PET is suitable for applications of high temperature. For both fresh as well as processed honeys, PET containers are commonly used. Their conveniences, high shock resistance, low weight, transparent nature and easy storage make PET bottles common for honey packaging. For plastic honey jars/bottles, the following different shapes are available (Kejriwal honey, 2018):

(i) Square PET Bottles (250–1000g): Their sizes are large and give more space for more honey.

(ii) Wide Hex PET Jars (125-1000g): These are wider and their plastic body make them simple to be transported.

(iii) Lava PET Bottles (250-500g): These provide limited choice of packaging sizes.

(iv) Apple Pet Jars (200-1000g): These look like apples in their shape, as the name implies. These shape make them to store more honey without elongated.

(v) Squeeze Pet Bottles (250-500g): The designs of these bottles are different due to which the bottle can be squeezed to spill out the honey.

Polypropylene (PP) which has the lowest density (900 kg/m^3), the highest melting point (160°C), and relatively low cost is another plastic widely used to pack honey. For the development of heat-sealable webs that can resist temperatures as high as 115–130°C, PP can be extrusion laminated to PET or to other high temperature-resistant films for sterilizing and use in retort pouches (Shubhra et al., 2013; Maddah, 2016). It has an oil and fat resistance and is a barrier to water vapor. The key food applications of PP include pots and tubes with injection-molding and blow-molding based wide-mouth jars and bottles for the retail packaging of honey.

In addition to PET and PP, other plastic materials used in honey packaging include LDPE and HDPE which are used to make large plastic buckets. These buckets are preferred for transportation and distribution of raw honey from collection/harvesting site to the processing/packing unit.

2.4 Other Packaging Materials used

Other packaging materials include stainless steel, aluminium or metal coated with food-grade plastics to prevent the honey oxidation. These materials are used for carryinglarge quantities of honey from one place to other or storing honey. During processing, the honey is stored in large stainless steel drums while stainless steel pellets are used during shipment of honey consignments.

2.5 Labelling of Honey

Honey bottles/jars today need to have an unusual design of the label to fit the container of interesting shape. For instance, in the case of a multi-sided square or hexagonal container, it is important to consider where the label is to be positioned; curves and corners are harder to label than flat surfaces. An individual label, a label seal or even a one-piece label can be placed on the top of jar lid. Labels must also have all the details and preferably a lot number shown to help the manufacturer to track issues (Koen et al., 2016).

The information on honey label is a significant part of the packaging because of details about brand/company and product. Most labels contain information such as:

- Brand
- Product name or honey description
- Provenance information like variety, region, flora
- Weight
- Country of origin
- Ingredients list
- Nutrition information
- Use and storage directions
- Any warning and advisory statements
- Manufacturer/packer/processer information like name and address
- Barcode
- Packing date
- Best before (usually ≥18 months)

The size, colour and contrast of this information must be taken into account for its legibility. The decision on colour for all elements of label is crucial to improve the positioning of brand and establish an appealing appearance in the supermarket shelves (Sial et al., 2011).

If honey bears the label "honey" or is labelled with more informative marks like the source of honey, such as "Lavender Honey" or "Clover Honey," etc.; then the ingredients section on the label is not required, as honey is the only ingredient in pure and natural honey. Honey labels are typically applied in glass jars or plastic bottles, so they need to be built from a flexible material that is waterproof so that the package surface is well adhered. A solid, permanent adhesive vinyl label facestock is a good option for honey stickers. It can also be made from paper, but a laminated or an additional protective layer against the elements will be needed. With a reflective and bright effect, the metallic materials capture attention. Another common material choice is clear film, as it allows customers to display the honey with an elegant "no label" look on the packaging. Glossy paper/film, uncoated paper, textured design paper or even eco-friendly materials are other choices.

Additional claims that appear on honey labels

Pure honey: Honey that is not combined with other ingredients, such as water, sucrose, corn syrup or other additives.

Raw honey: This is in raw condition, usually not pasteurized but, may crystallize, opaque or transparent containing pollen, propolis, honeycomb-bits, etc.

Unfiltered honey: It is not filtered and may possess pollen grains and other bee residues.

Pasteurized honey: It is heated at 72°C or more to kill yeast cells and reduce crystallization.

Organic honey: Honey which is produced without using synthetic pesticides, chemicals and environmental pollutants.

Blossom / nectar honey: Honey that is made from the nectar of plants.

Honeydew honey: Honey is made from plant sucking insects' excretions/or plant secretions.

Comb honey: Honey is collected in the honeycomb cells by bees and sold as whole or part of the comb.

Chunk honey: This contains one or more pieces of comb honey.

Drained honey: It is obtained from honeycombs by draining.

Extracted honey: It is obtained from honeycombs by centrifuge.

Pressed honey: Honey which is obtained from honey combs by pressing, with or without heat of up to 45°C.

Filtered honey: Honey that is highly filtered in a way that removes a significant amount of pollen

Baker's honey: It is used as ingredients in other foods.

It is a common practise in which undesirable substances are filtered from honey under pressure, such as small comb or dead bees and honey is thus treated, without being called "filtered honey." If, however, fine filters are used in order to extract a large amount of pollen – for example, when honey is finely filtered in order to enhance shelf life and clarity – the product should be identified as 'filtered honey,' not simply 'honey.' A nutritional declaration for energy, fat, saturated fats, carbohydrates, sugars, proteins and salt would have to be marked for the filtered honey; but a nutrition declaration does not require in case of unprocessed honey. When baker's honey and filtered honey are sold in bulk containers, both the container must highlight the full product names. Baker's honey sold as a food shall be labelled in a close proximity by the name 'intended for cooking only.' Furthermore, if the honey is a combination of honeys harvested from more than one country, one of the following declarations can be used, as an alternative to the listing of different countries of origin: (i) 'Blend of EU honeys', (ii) 'Blend of non-EU honeys' and (iii) 'Blend of EU and non-EU honeys' (National Honey Board, 2021).

The honey package label should be referred to as the "honey" label or perhaps must give a floral source indication, such as "Rapeseed honey" or "Multifloral honey" (FSSAI, 2011a). The net weight, the name and address of honey dealer, the packer's registration number and the nutrition facts table should also be given. Honey can be labelled as: (i) Honeydew honey, (ii) Blend of Honeydew Honey and Blossom Honey – If the product is mixture of Blossom or Nectar Honey and Honeydew honey and (iii) *Carviacallosa* Honey – If the honey is derived from flower of *Carviacallosa* plant (FSSAI, 2011a). However, there are no separate labelling guidelines for honey that require an attention because of growing cases of honey adulteration and fraudulent.

Food Safety and Standards Authority of India made the Food Safety and Standards (Packaging and Labelling) Regulations, 2011 (FSSAI, 2011b), but now the Food Authority has divided these regulations into two regulations,- (i) the Food Safety and Standards (Packaging) Regulations, 2018; and (ii) the Food Safety and Standards (Labelling and Display) Regulations, 2020.

2.6 Food Safety and Standards (Packaging) Regulations, 2018 (FSSAI, 2018)

General requirements for packaging materials

1. Any material which comes in direct contact with food or likely to come in contact with food during supply chain shall be of food grade quality.
2. Packaging materials shall be suitable for product type, storage conditions and equipment for filling, sealing and packaging of food.
3. Packaging materials shall be able to withstand mechanical, chemical or thermal stresses encountered during normal transportation.
4. Food products shall be packed in clean, hygienic and tamper-proof package or container.
5. The sealing material shall be compatible with the product and the containers as well as the closure systems used for the containers.

6. Plastic containers of capacity 5 liter and above and Glass bottles, which are reused for packaging of food, shall be suitably durable, easy to clean or disinfect.
7. Printing inks for use on food packages shall conform to IS: 15495.
8. Printed surface of packaging material shall not come into direct contact with food products**.**

Specific requirements for packaging materials

(a) Glass containers intended to come in contact with food products
   a. Free from blisters, mold marks, stones, chippings, cords, seeds, and other visible defects.
   b. Smooth surface without cracks, pinholes, and sharp edges.
   c. Sealing surface shall be free from hairline cracks and prominent seam marks.

(b) Plastic materials intended to come in contact with food products
   a. Plastic materials used - conform to Indian Standards specifications (Schedule – III)
   b. All plastic packaging materials shall pass the prescribed overall migration limit of 60mg/kg or 10mg/dm^2 when tested as per IS 9845 with no visible color migration.
   c. Pigments or Colorants for use in plastics in contact with food products shall conform to IS: 9833.
   d. Products made of recycled plastics shall not be used for packaging, storing, carrying or dispensing articles of food.

Suggested packaging materials for honey in Schedule –IV

- Glass bottle with Metal Caps or Plastic (polypropylene (PP) or High-density polyethylene (HDPE) Caps
- Plastic-based Thermoformed container
- Blister Pack with foil or polyethylene lid
- Polyethylene Terephthalate (PET) container with Plastic Caps
- Plastic laminated Tube

2.7 Food Safety and Standards (Labelling And Display) Regulations, 2020 (FSSAI, 2020b)

Food Business Operator shall comply this regulation by January 1, 2022. Under the provisions for labelling requirements, every package shall carry the name of the food, list of ingredients, nutritional information, and declaration of vegetarian logo (a green colour filled circle inside a green colour square box) or non-vegetarian logo (a brown colour filled triangle inside a brown colour square box). Further, the labelling requirement includes declaration regarding food additive, name and complete address of the concerned brand owner, manufacturer, marketer, packer, bottler as the case may be and FSSAI logo with license number. Besides, net quantity, retail sale prices, consumer care details, lot /code/batch number, date marking should be properly mentioned. The regulations say that "Date of manufacture or packaging" and "Expiry/Use by" shall be declared on the label. However, the expression "Best before" may also be used as optional or additional information.

2.8 Storage Of Honey

One of the key facts about honey is that it does not spoil. However, over time, honey is vulnerable to physicochemical changes and lose taste and fragrance and appears to darken as well. As honey preservation depends on temperature, it is difficult to define the shelf life of honey. A shelf life of almost one and half years or two years is sometimes specified for practical – and business – purposes. However, honey properly stored preserves its quality for longer (Fallico et al., 2009).

Storage of honey in air-tight containers is necessary as the water content of honey is protected. Honey must be kept in glass jars for best shelf stability. Some plastic containers may cause the water loss or leach chemicals into honey. PET plastic should be used for the best storage of storage. The long-term storage of honey in bulk is best allowed in stainless steel containers. Honey should not be stored in non-stainless steel containers as honey may be affected by corrosion.

Honey should never be stored above 37°C temperatures. Honey damage (in terms of taste, flavor and nutritional value) is cumulative, and honey should not be heated particularly for long periods. The optimal temperature for the storage of honey is from 10-25°C according to the national honey board. In addition, when stored in air-tight containers and cool dry places away from direct sunlight, honey can achieve optimum shelf-life when stored for long term. It is suggested to store honey in its original container, but any glass jar or food-grade plastic container will function as well. There is no need to refrigerate/freeze honey as the colder temperature enhances the honey solidification/crystallization which makes it difficult to use. In such cases, honey needs to be heated so that it returns to a liquid state that would harm the sensory as well as nutritional quality of the honey.

CHAPTER- 3

INTRODUCTION ON FSSAI REGULATION

Honey is a widely consumed natural product, not only desirable for its taste and nutritional value, but also for many medicinal benefits such as antibacterial, antifungal, anti-inflammatory, and antioxidant effects. Regarding its nutritional value, honey is essentially composed of water and various types of sugars which mainly consist of fructose and glucose. Other valuable components, such as vitamins, minerals, enzymes, amino acids, and numerous volatile compounds, are alsopresent (Schievano et al., 2013). These compounds vary among different honeys due to factors such as the geographical location, botanical source,season of extraction, climatic conditions, honey extraction procedure, and storage conditions. These compounds arealso used to differentiate honeys by botanical and geographical origins, as well as to define their quality (Erejuwa et al., 2012). At the International level Codex and EU directive are responsible to form honey standards and at the National Level, FSSAI is responsible for establishing honey standards.

European directive 2001/110/EC and revised Codex standard for honey (Codex, 2001) The Codex standard for honey adopted by the Codex Alimentarius Commission in 1981, revised in 1987 and 2001, has voluntary application and serves in many cases as a basis for national legislation (Codex, 2001). The European Council followed the recommendations of Codex, and issued Directive 2001/110/EC (EC, 2001), amended 2014/63/EU (EU, 2014) that laid down the production and trading parameters of honey within the Member States of the EU (EU, 2011, 2014).

At the national level, through a notification dated 1 July 2020 the FSSAI has issued directions for the operationalization of the revised standards for honey in accordance with the Food Safety and Standards (Food Product Standards and Food Additive) Amendment Regulations, 2019.

Indian honey standards are not fully harmonized with the EU legislation whereas Countries like Bulgaria, Cyprus, England, France, Malta, Slovenia, Spain and Switzerland have harmonized their honey National standards fully with EU legislation without different decisions.

3.1 Definition of Honey By Codex. Directive and FSSAI

According to the Codex (2001), the honey is "natural sweet product produced by bees from the nectar plants (blossom honey) or from secretions of living parts of plants or secretion of insects (honeydew honey) Bees collect, deposit, dehydrate, store and leave in the honey comb to ripen and mature".The directive defines honey as "the natural sweet substance produced by *Apismellifera*bees" differentiating it by this way from the honey that is produced by other species of bees (*Micrapis, Megapis,*and*Meliponines*).

In the Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011, in regulation 2.8 relating to Sweetening agents including Honey, in the sub-regulation 2.8.3 related to Honey and its by-products **t**he definition (Clause (1) of honey has been amended to the following

(1) Honey is the natural sweet substance produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honeycomb to ripen and mature.

a) Blossom Honey or Nectar Honey is the honey which comes from nectars of plants.

b) Honeydew Honey is the honey which comes mainly from excretions of plant sucking insects (*Hemiptera*) on the living parts of plants or secretions of living parts of plants.

3.2 Honey Standards by FSSAI

Honey shall comply with the following amended requirements and limits:

S. No	Parameters	Limits
1,	Specific gravity at 27° C, Min.	1.35
2,	Moisture percent by mass, Max.	20
3.	Total reducing sugars, per cent. by mass, Min. (a) For the Honey not listed below (b) Carviacallosa and Honeydew honey (c) Blends of Honeydew honey with blossom honey	 65 60 45
4.	Sucrose, per cent, by mass, Max. (a) For the Honey not listed below (b) Carviacallosa and Honeydew honey, Max.	 5.0 10
5.	Fructose to Glucose ratio (F/G Ratio)	0.95-1.50
6.	Total Ash, per cent. by mass, Max.	0.50
7.	(a) Acidity expressed as formic acid, per cent. by mass, Max (b) Free Acidity milliequivalents acid/ 1000 g, Max.	0.20 50.0
8.	Hydroxymethylfurfural (HMF) mg/kg, Max.	80.0
9.	Diastase activity, Schade units per gram, Min.	3
10.	Water insoluble matters, per cent. by mass, Max. (a) For the Honey not listed below (b) For Pressed honey	 0.10 0.5
11.	C4 Sugar, per cent. by mass, Max.	7.0
12.	Pollen count and plant element/g, Min.	5000
13.	2-Acetylfuran-3-Glucopyranoside (2-AFGP) as Marker for Rice Syrup	Absent**
14.	Foreign oligosaccharides (Max. Percent Peak]	0.7
15.	Proline, mg/kg, Min.	180
16.	Electrical Conductivity: (a) Honeys not listed under Honeydew, Max. (b) Honeys listed under Honeydew, Min.	 0.8 mS/cm 0.8 mS cm
17.	(a) $\Delta\delta^{13}C$ Max*. (Maximum difference between all measured values $\delta^{13}C$); per mil (b) $\Delta\delta^{13}C$ Fru - Glu (The difference in $^{13}C/^{12}C$ ratio between fructose and glucose); per mil (c) $\Delta\delta^{13}C$ Protein - Honey (The difference in 13C/12C between honey and its associated protein extract); per mil	± 2.1 ± 1.0 ≥ - 1.0

*$\Delta\delta^{13}C$ Max. is the maximum difference observed between all possible isotopic ratios measured ($\Delta\delta^{13}C$ fructose-disaccharides / $\Delta\delta^{13}C$ fructose-trisaccharides / $\Delta\delta^{13}C$ fructose-protein $\Delta\delta^{13}C$ glucose disaccharides / Δδ13C glucose-trisaccharides / $\Delta\delta1^{3}C$ glucose-protein/$\Delta\delta^{13}C$ disaccharides-trisaccharides/ Δδ13C disaccharides-proteins Δδ13C trisaccharides-protein).

**Minimum Required Performance Level- 1mg/kg

Reinstating the standards for specific marker for Rice Syrup and Foreign Oligosaccharides by FSSAI

Standards for honey had been notified on 31 July 2018 and subsequently there was a revision for the parameter for pollen count and deletion of parameters for specific marker for Rice Syrup (SMR), Trace marker for Rice Syrup (TMR) and foreign oligosaccharides on 29 October 2019.However, based on the approval of Food Authority on the method of detection of 2-Acetylfuran-3-Glucopyranoside (2-AFGP)/3-0-Alpha-D-Glucosyl Isomaltol, the specific marker for Rice Syrup (SMR), LC-MS the parameter specific marker for Rice Syrup (SMR) was reinstated through a notification dated 5 June 2020.Further, The Scientific Panel on Methods of Sampling and analysis in its 28th Meeting held on18 June, 2020 has recommended the method for determination of Foreign Oligosaccharides in Honey. Hence, it has been decided to reinstate the parameter Foreign Oligosaccharides also in the standards of Honey.).

3.3 FSSAI specific provisions for labeling of honey

In addition to the labeling provisions as given in Food Safety and Standards (Packaging and Labeling) Regulations, 2011, the following specific provisions shall be applicable for labeling of honey:

(a) Honey shall be labeled as:

1. **Honeydew Honey** – If the product complies with the definitions given in by FSSAI "Honey which comes mainly from excretions of plant sucking insects (*Hemiptera*) on the living parts of plants or secretions of living parts of plants"
2. **Blend of Honeydew Honey and Blossom Honey** – If the product is mixture of Blossom or Nectar Honey and Honeydew honey
3. ***Carvia Callosa* Honey** – If the honey is derived from flower of *Carvia callosa* plant which is described as thixotropic and is gel like extremely viscous when standing still and turns into liquid when agitated or stirred.

Pressed honey–If the honey is obtained by pressing brood-less combs, honey shall be labelled as "PRESSED HONEY". If honey belongs to any of the categories mentioned at (a) above and also falling into the category of pressed honey, it shall be labelled as "Pressed Honeydew Honey" or "Pressed and Blend of Honeydew Honey and Blossom Honey" or "Pressed *Carvia Callosa* Honey".

(b) Honey may be labeled as follows, as per floral or plant source, if it comes from any particular source and has the organoleptic, physicochemical and microscopic properties corresponding with that origin. It shall be in addition to the labeling requirements as given at (a) above:

1. **Mono-floral Honey** – If the minimum pollen content of the plant species concerned is not less than 45 percent of total pollen content;
2. **Multi-floral Honey** – If the pollen content of any of the plant species does not exceed 45 percent of the total pollen content;"

Lack of national regulations (FSSAI) or technical criteria regarding the characteristics of mono-floral honeys

According to the Codex and Directive, honey can be labeled by floral or vegetable origin, if the product comes entirely or “mainly” from the indicated source and possesses the organoleptic, physicochemical and microscopic characteristics of the source. However, the important characteristics of mono-floral honey are not defined by codex and Directive. Similarly, FSSAI has also not given any regulation related to characteristics of mono-floral honey.

In order to define the word “mainly” the minimum amount of pollen (to determine the botanical origin) has been established in five European countries(Croatia, Greece, Germany, Italy and Serbia). Greece has national limits regarding the characteristics of eight mono-floral types of honey (AXS, 2004), Germany has legislation of organoleptic, microscopical and physicochemical characteristics of ten floral and three honeydew honeys (Leita¨tze, 2011), Serbia has legislated the pollen limits of eight mono-floral honeys (Serbia Ordinance, 2003) and Turkey provides physicochemical characteristics of almost all the mono-floral honey that are produced in that country (Turkish Food Codex, 2012).

3.4 Comaprison of Honey Standards given by Codex, European Directive And FSSAI

Moisture Content: Codex, European Directive and FSSAI

The moisture content in honey depends on flower sources, beekeeping manipulations, and climatic conditions etc. Normally, honey from well-sealed combs (ripened honey) has the water content less than 18%. Codex and European Directive set limits for moisture content no more than 20% with the exception of heather honey (Calluna vulgaris) which is permitted having up to 23%. FSSAI set the limits for moisture content no more than 20% without any exception.

Fructose and Glucose content: Codex, European Directive and FSSAI

The sum of glucose and fructose is fulfilled by most of the floral honey. Both Codex and Directive required the sum of fructose and glucose content for blossom honey to exceed 60% and for honeydew honey and blends of honeydew honey with blossom honey to exceed 45%.FSSAI required the reducing sugars content for blossom honey to exceed 65% and for blends of honeydew honey with blossom honey to exceed 45%.

Fructose/glucose ratio

Carbohydrates are responsible for some of the key functional properties in honey. The important aspect of honey carbohydrate composition is crystallization. The fructose/glucose ratios are parameters which are used to help predict the tendency of honey to crystallize. In addition, sugars, particular glucose and fructose, as the primary ingredients in honey play a critical role in the crystallization. Because of the lower solubility, the glucose is believed to be the crystallizing sugar.It has been reported that pure glucose may crystallize as α-D-glucose monohydrate (Escuredo et al., 2014). Honey high in glucose sugar, with a low fructose to glucose ratio will crystallize more rapidly, such as alfalfa, cotton, dandelion, mesquite, mustard and rape. Honey with a higher fructose to glucose ratio (containing less than 30% glucose) crystallizes quite slowly and can stay liquid for several years without special treatment, for example, robinia (black locust), sage, longan, tupelo and jujube/sidr. According to the FSSAI standards, Fructose /Glucose ratio should be in the range of 0.95-1.50.

Sucrose content

The general provision for sucrose content is less than 5% with the exception (Eucalyptus, Robinia, Citrus and Lavandula) for both Codex and Directive (PersanoOddo & Piro, 2004). FSSAI fixed the sucrose content less than 5% in all types of Indian Honeys.

Electrical conductivity

Blossom and honeydew honey are differentiated by electrical conductivity. Electrical conductivity less than 0.8 $mS.cm^{-1}$ indicates blossom and more than 0.8 $mS.cm^{-1}$ indicates honeydew honey. FSSAI fixed the above mentioned values for blossom and honeydew honey.

Diastase activity and HMF

Diastase is inactivated and HMF is formed when honey is heated for processing and blending. Both changes occur also during storage.When the diastase drops below the limit of 8 DN or HMF exceeds 40 mg.kg−1, the quality of honey is considered as degraded.The provision for Diastase activity is more than 8 and HMF less than 40 mg/kg for both Codex and Directive. The provision for Diastase activity is more than 3 and HMF less than 80 mg/kg for FSSAI standards.

3.5 FSSAI STANDARDS TO CONTROL AUTHENTICITY OF HONEY

Plants can be divided into C3 and C4 plants based on the metabolism of carbon dioxide during photosynthesis. Most of flowering plants including wheat rice etc belongs to the C3 plants (Low c13 to c12 ratio) whereas corn and sugarcane belongs to the C4 plants (high C13 to C12 ratio.

These differences in the carbon-13 to carbon-12 ratios observed between honey and cane syrups can be precisely measured using a stable isotope ratio mass spectrometer.

The sensitivity of the method is limited by the natural variation in honey and sugar syrup's stable carbon isotope ratios. This can be improved by extracting the protein from the honey and using it as an internal isotopic reference point. When C4 sugar is added to pure honey, the 13C/12C ratio will be altered, whereas it corresponding 13C/12C ratio protein extract will remains constant. The difference accepts in 13C/12C results between honey and its associated protein extract is -1δ‰ deviation, which provides the international benchmark of 7% of C4 sugar added. This is the international tolerated limit established to consider the honey pure or not. FSSAI also fixed the same value in the standards. A negative result of 13C –EA-IRMS method is not a proof of authenticity of honey but only exclusion of C_4 Plants.

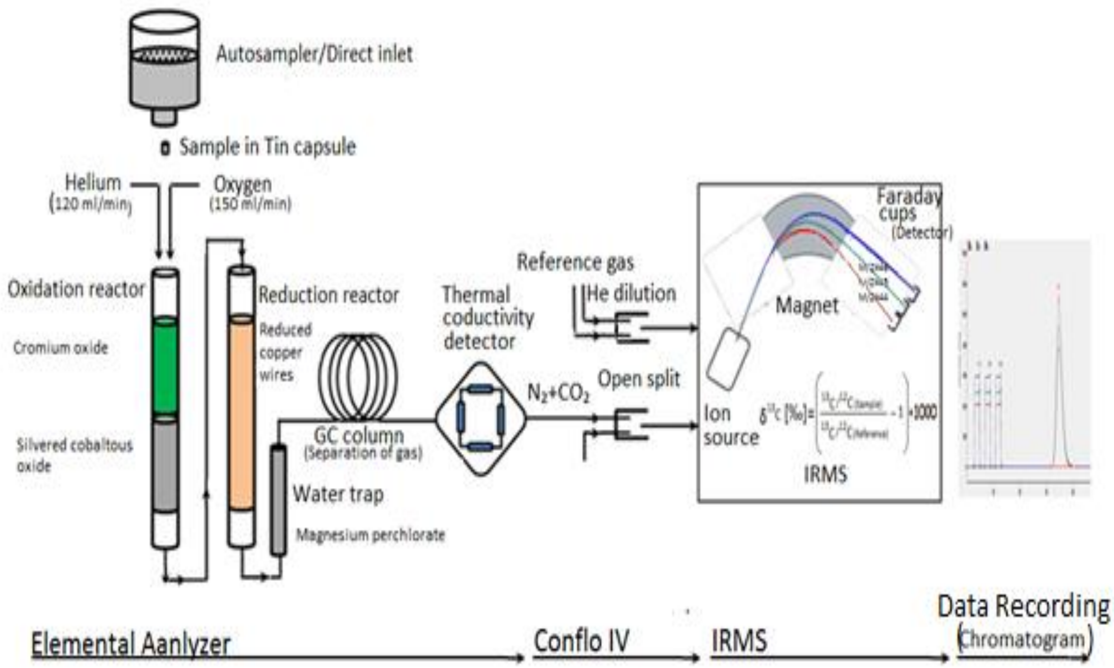

Fig 1. Schematic diagram of elemental analyzer-isotope ratio mass spectrometer for stable carbon isotope analysis

LC-IRMS: Rice syrup /Beet syrup/ other (C-3 sugars)

Liquid chromatography coupled to molecular mass spectrometry (LC/MS) has been a standard technique since the early 1970s but liquid chromatography coupled to high-precision isotope ratio mass spectrometry (LC/IRMS) has only been available commercially since 2004. This development has, for the first time, enabled natural abundance and low enrichment δ13C measurements to be applied to individual analytes in aqueous mixtures creating new opportunities for IRMS applications, particularly for the isotopic study of biological molecules (McCullagh, 2010). C3 sugars derived from plants like wheat, sugar beet, rice or tapioca. The absolute δ13C isotopic values cannot be used for differentiation of honeys and C3 sugars in this case, because the isotopic values of nectar and honeydew from which the honey is produced is also derived from C3 plants. A specific feature of honey can be utilized: the δ13C values of honey protein and the individual sugars of honey are almost identical in authentic honeys. By comparing the individual deviations between the δ13C values of the different honey fractions it can be evaluated whether the honey is authentic or has been manipulated with foreign sugars (C4/C3) (δ13C values of authentic honey should be fall in the naturally range of ± 1% for δ13C (fructose–glucose) and ± 2.1% for δ13C (%) max. (Maximum difference between all measured δ13C values) (Elflein and Raezke, 2008) The proper technical solution for this analytical problem is the online hyphenation of liquid chromatography (LC) with IRMS (LC-IRMS). This test method is now used as the main generic C3 sugars adulterated honey detection in the International trade for many years.

Specific marker substances to check adulteration

There are methods detecting specific marker substances indicating the presence of sugar syrups in honey by GC-MS, LC-MS or LC-ELSD.For example the honey foreign oligosaccharides (oligosaccharide ≥ DP4) which are a remainder of the enzymatic starch degradation and do not occur naturally in flower or honeydew honey.The disadvantage of these specific marker methods is that they can only detect and prove one certain type of adulteration.

Nuclear Magnetic Resonance to check adulteration

NMR test is a universally accepted test for identifying honey adulteration. The reason is that the NMR testing instrument undergoes **honey profiling.** This means it has created a powerful and large scale database to run the test for detecting honey adulteration with great success.

Honey Profiling Database

- Nearly 18000 authentic and adulterated honey samples. These samples come from 50 different countries and around 100 botanical varieties.
- It has 1900 known adulterated honeys data adulterated using sugar syrups.
- Clearly defined data of **monofloral** (single flower nectar) and **multi-floral honey** from a **variety of flowers and honeydew** of each country.
- 53 percent from the Asia, 27 percent from America, 15 percent from Europe

- More than 100 samples from the USA, Guetamala, Austria, El Salvador, Serbia
- More than 200 samples from New Zealand, Brazil, Thailand & India
- Monofloral and Polyfloral blends of honey from different countries
- 2000 honeydew samples.

Results of NMR test

- NMR test has been acknowledged and **regarded** as a **fingerprint test** for detecting honey adulteration throughout the world.
- It detects all forms of **sugar syrup** adulterants from **C4 plants** like corn and sugar cane. Similaly, **C3 plants** like rice, beet and wheat sugar syrups.
- NMR test has **nearly 60 markers** which are applied for **per honey sample**. This means the NMR test **scans through 60 various signs of any adulteration** at the **molecular level** in honey. Thus, no adulterants can skip this test.

3.6 Antibiotics in Honey

Apiculture faces numerous challenges, including changes in agricultural practices, an extensive use of pesticides and an ever more frequent use of antibiotics administered to prevent bee infections caused by pathogenic microorganisms (Van Veen et al., 2014). For example oxytetracycline, from the family of tetracyclines, is used by beekeepers to treat bacterial infections such as American Foulbrood (AFB), a significant brood disease in honeybee colonies caused by the gram-positive bacteria *Paenibacillus larvae* (Genersch, 2010; Tian et al., 2012; Rokop et al., 2015). A complementary antibiotic used to treat honeybee colonies is Tylosin. Both of these antibiotics are of broad spectrum activity and are approved by the USDA for livestock use (Broadway et al., 2014). There are several international reports of antibiotic residues in honey samples. Oxytetracycline and chloramphenicol residues have been found above the regulatory standards in honey (Ortelli et al., 2004; Saridaki-Papakonstadinou et al., 2006). The use of antibiotics in beekeeping is illegal in some EU countries. However, there are no MRLs established for antibiotics in honey according to European Community regulations, which means that honey containing antibiotics residues are not permitted to be sold (Forsgren, 2010).

Honey is not included in the "tissues" (foods) mentioned in Annex I of Regulation (EEC) No 2377/90 and related Regulations world over.Therefore, according to Article 14 of the same Regulation, the use of antibiotics in honey bees is not permitted and cannot be authorized. Antibiotics in honey are therefore considered "unauthorized substances" and "ZERO" tolerance applies. As per FSSAI, the use of any antibiotic is not permitted during the honey production. However, in order to test the misuse of antibiotics, the antibiotics specified in column (2) shall not exceed the Maximum Residue Performance Level (MRPL) specified in column (3) of the Table.

Table 1 Maximum Residue Performance Level for antibiotics in honey

S. No.	Name of Antibiotics	Maximum Residue Performance Level (MRPL) (µg/Kg)
(1)	(2)	(3)
1	Chloramphenicol	0.3*
2	Nitrofurans and its metabolites	1
3	Sulphonamides and its metabolites	10 either individually or collectively
4	Streptomycin	10 either individually or collectively
5	Tetracycline	10
6	(a) Oxytetracycline	10
	(b) Chlortetracycline	10
7	Ampicillin	10
8	Enrofloxacin	10
9	Ciprofloxacin	10
10	Erythromycin	10

Two main approaches are used to determine the content of antibiotic residues in honey:

- **Screening tests**: The simple tests provide qualitative or quantitative information, enabling determination of a single target analyte
- **Multistage analytical methodologies**: With multi-stage methods, a fairly broad spectrum of analytes can be determined in one analytical run.

Table 2 Assay used to determine the contents of various antibiotic residues in honey

Assays	Principle	Remarks
Charm II (Charm Sciences, Inc.)	Target analytes bind to receptors and the level ofradioactivity of H3 or C14 is determined	Used in screening tests for sulfonamides,tetracyclines, beta-lactams, macrolides, amphenicolsand

		streptomycin amino-glycosides (Morlot and Beaune, 2003)
ELISA (enzyme-linked immunosorbent assay)	An immunological test used for the quantitativedetermination of antibiotics by means of antibodies.	The method is frequently applicable only inpreliminary quantitative analysis. It enables detection of an antibiotic in honey in range above10–50 ppb, depending on its chemical properties (Bogdanov, 2003)
Sulfasensor (CAP Transia, Biacore)	This test employs an antibody capable of detecting 10 key sulfonamides. The protocol includes a rapid acid hydrolysis step to liberate the bound sulphonamide residues from the sugar component.	Used in screening test for sulfonamides at the target detection level of 25 ppb (Moeller et. al., 2007)
Tetrasensor (Unisensor)	The test uses two elements: a reagent containing an amount of labeled receptor and a dipstick consistingof a set of two capture membrane lines. The first line captures the remaining active receptor and the second line takes the excess of reagent that has passedthrough the first line.	Used as a screening test for the quick determination of tetracyclines present in honey even at 10 ppb levels (Reybroeck et al., 2007)

ELISA Assay: The basis of all applied ELISA tests is the antigen-antibody reaction. Antibodies against analyte of interest are placed in microtiter wells. Free molecules of analyte and enzyme conjugate compete for the antibiotic antibody sites. Test principle is competitive enzyme immunoassay (Zhang & Cheng, 2017). For investigation of ELISA method, ELISA kits produced by different companies can be used (RIDASCREEN Enrofloxacin kit (R3113), Penicilin ELISA kit (R3103), Chloramphenicol ELISA kit (R1505), Gentamicin ELISA kit (R5111), Tylosin ELISA kit (R5151), Tetracycline ELISA kit (R3503), and Sulfonamide ELISA kit (R3004) by R-Biopharm, Germany). For the determination of certain antibiotics clean-up step of crude honey extract was needed, by using solid phase extraction method. For that purpose, C18 columns are used according to proposed procedure of ELISA manufacturer for honey samples (Martela,et al., 2006).

The Tetrasensor Honey test kit is a receptor-based assay using dipsticks for a rapid screening (30 min) of honey on the presence of tetracyclines. The test was validated according to Commission Decision 2002/657/EC. The test detects tetracycline, oxytetracycline, chlortetracycline, and doxycycline in honey in a specific and sensitive way. Depending on the type of tetracycline. It was reported that detection capabilities (CCβ) between 6 and 12 μg/kg could be obtained (4–7 μg/kg for dried dipsticks).The Tetrasensor Honey test kit is a simple and reliable test that can even be used at the production site (Reybroeck et al., 2007).

A method has been developed and validated for the simultaneous analysis of different veterinary drug residues (macrolides, tetracyclines, quinolones, and sulfonamides) in honey. Honey samples were dissolved with Na_2EDTA, and veterinary residues were extracted from the supernatant by solid-phase extraction (SPE), using OASIS HLB cartridges. The separation and determination was carried out by ultraperformance liquid chromatography coupled to tandem mass spectrometry (UPLC-MS/MS), using an electrospay ionization source (ESI) in positive mode. Data acquisition under MS/MS was achieved by applying multiple reaction monitoring (MRM) of two ion transitions per compound to provide a high degree of sensitivity and specificity. The method was validated, and mean recoveries were evaluated at three concentration levels (10, 50, and 100 μg/kg), ranging from 70 to 120% except for doxycycline, erythromycin, and tylmicosin with recovery higher than 50% at the three levels assayed. Relative standard deviations (RSDs) of the recoveries were less than 20% within the intraday precision and less than 25% within the interday precision. The limits of quantification (LOQs) were always lower than 4 μg/kg. The developed procedure was applied to 16 honey samples, and erythromycin, sarafloxacin, and tylosin were found in a few samples(Vidal et al., 2009).

CHAPTER- 4

OPPORTUNITIES FOR MICRO/UNORGANIZED ENTERPRISES

4.1 PM-FME Scheme:

Ministry of Food Processing Industries (MoFPI), in partnership with the States, has launched an all India centrally sponsored "PM Formalisation of Micro Food Processing Enterprises Scheme (PM FME Scheme)" for providing financial, technical and business support for up-gradation of existing micro food processing enterprises. The objectives of the scheme are :

I. Support for capital investment for up-gradation and formalization with registration for GST, FSSAI hygiene standards and UdyogAadhar;
II. Capacity building through skill training, imparting technical knowledge on food safety, standards & hygiene and quality improvement;
III. Hand holding support for preparation of DPR, availing bank loan and up-gradation;
IV. Support to Farmer Producer Organizations (FPOs), Self Help Groups (SHGs), producers cooperatives for capital investment, common infrastructure and support branding and marketing.[i]

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