# Review:Extraction And Bioactivity of Oleoresins Fromred Pepper (*Capsicum annuum* L.)

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## I. INTRODUCTION

Red pepper *(Capsicum annuum L.)*is one of the most important spices, widely cultivated and is used all over the world. Red pepper is part of a group of about twenty plant species belonging to the genus *Capsicum* of the family Solanaceae. Red pepper is the dried, ripened fruit pod from pungent (hot) varieties of the*Capsicum*species. It is also referred to as Cayenne pepper. In addition to Cayenne, red pepper also goes by the names including, chilli pepper, hot pepper, and red chilli. The name*Capsicum*has been derived from Latin word for “capsule” which refers to the shape of the fruits (Kumar *et al.,* 2006). Red pepper is an important agricultural crop, not only because of its economic importance, but also for the nutritional value of its fruits, mainly due to the fact that they are an excellent source of natural colours and antioxidant compounds. Peppers are classified by fruit characteristics, i.e pungency, colour, shape, flavour, size, and their use (Babu*et al.,* 2014).

Commercial red chilli oleoresins are mainly used as a spice supplied in pungency ratings between 80,000 and 500,000 Scoville units (approximately 0.6-3.9% capsaicin) and a range of colour. Paprika extract is obtained from varieties of red pepper, from which paprika powder is produced. It has a high colour value, but little or no pungency. One kg of paprika extract replaces 12-15 kg of paprika powder with respect to colour intensity (Cantrill*et al.,* 2008).

Red pepper has been used since ancient times as a source of pigment to add or change the colour of foodstuffs, making them more attractive and acceptable to consumers. As a food colourant, red pepper has traditionally been in the form of paprika (ground powder), although today oleoresins are widely used. The red pepper is a vegetable known for its high antioxidant capacity. Fresh red peppers have especially high ascorbic acid content at 116 mg per 100 g. The red colour is due to a variety of carotenoid pigments, which includes *β*-carotene with pro-vitamin A activity and oxygenated carotenoids, such as capsanthin, capsorubin and cryptocapsin, which are distinct to this genus and are shown to be effective free radical scavengers. (Sarojam*et al.,* 2020).

Uses of red pepper in traditional medicines have included treatments for sore throat, cough, toothache, stomach ailments, rheumatism, wound healing, and parasitic infections. (Sanati*et al,* 2018). Furthermore, the dried, ripe fruit of the *Capsicum* species provides ingredients for skin-conditioning agents, external analgesics, flavouring agents, cosmetic fragrances, and repellant sprays. There is a cultivar of red pepper, CH-19 sweet, which lacks the strong pungency or irritant properties of red pepper, yet appears to maintain similar biological activities.Food industry is the major user of the genus *Capsicum sp.* fruits because they are used as colouring and flavouring in sauces, soups, processed meats, snacks, sweets, soft drinks, and alcoholic beverages (Pawar*et al.,* 2011).

Red pepper oleoresin is a viscous liquid or semi-solid material derived by extraction from finely ground powder, which contains the aroma and flavour of its source. High-pungency *Capsicum* oleoresin is produced primarily in India, Africa, and China(Krithika*et al.,* 2014). Paprika oleoresin has little to no pungency, and is used for its colour and flavour properties, while *Capsicum* oleoresin can have levels up to 10 %, and is used primarily as a source of high pungency.Red pepper oleoresin is used as a source of both colour and pungency in canned meats, sausages, smoked pork, sandwich spreads, soups, and in dispersed form in some drinks such as ginger ale and orange juice. *Capsicum* oleoresin is used as a source of pungency in many products, especially chilli sauces. Oleoresin has considerable advantages over dried chilli, including more stable colour retention, easier to handle compared to the rather bulky dried chilli, and the ability to mix and dilute oleoresin with other substances to produce a range of colour and/or pungency values **(**Berke*et al.,* 2012).

The use of *Capsicum* oleoresins has increased owing to its advantages over other traditional spices. These include obtaining higher quality products with the desired content of bioactive and flavoured substances. The wide diversity of extraction methods including water extraction, organic solvent extraction, microwave-assisted extraction, and ultrasound assisted extraction as well as supercritical fluid extraction. Moreover, pre-treatments such as chemical treatments, osmotic dehydration, sun and oven drying, and freeze-drying are commonly used before the extraction processes (Doymaz*et al.,* 2002).

*Capsicum* or chilli species are commoly used in almost every cuisine as spices for their pungency, colour and flavour. Capsaicin is the main compound in chilli which is responsible for the pungent taste and various health benefits (Riquelme*et al.,* 2016). Capsaicin is an alkaloid present in the placenta of the fruit, which can directly reduce various free radicals and has diverse prophylactic and therapeutic uses in medicine. The applications of capsaicinoids in pharmaceuticals are attributed to its antioxidant, anticancer, antiarthritic and analgesic properties. It has also attained a great importance because of having 'oleoresin', which permits better distribution of colour and flavour in foods.Red chilies are great source of vitamin C. Chilli contains good amount of other antioxidants such as vitamin A, B-complex group of vitamins such as niacin, pyridoxine (vitamin B6), riboflavin and thiamin (vitamin B1) and flavonoids like β-carotene, α-carotene, lutein, zea-xanthin, and cryptoxanthin. Chilli also carries different minerals like potassium, manganese, iron, and magnesium (Chakrabarty*et al.,* 2017).

Red pepper or vegetable peppers are rich sources of bioactive compounds in addition to vital carotenoids. The flesh and seeds of such pepper contain considerable amounts of different homologues of tocopherol, the highly reactive components of vitamin E. The major homologue in the fruit flesh is N-tocopherol, the biologically most active component of vitamin E, while in the seeds mainly O-tocopherol can be found, which plays an important role being a very reactive antioxidant, in the stability of paprika products. The tocopherol homologues can be separated and quantitatively determined at high sensitivity by using normal-phase chromatographic procedures. These methods separate the tocotrienols and the unsaturated derivatives of tocopherol homologues along with L-ascorbic acid, the most biological active form of vitamin C and the most important water-soluble antioxidant in spice and vegetable pepper products. In addition to its nutritional significance, it plays an interesting role as the first oxidation barrier at postharvest stages of red pepper. Several chromatographic methods have been developed, optimised and validated for the qualitative and quantitative determination of vitamin C components in different food stuffs including paprika products (Enssaf*et al.,* 2016).

## II. REVIEW OF LITERATURE

Major health benefits of red pepper are primarily due to the presence of capsaicin, a thermogenic compound. It has an overall positive effect on the health and has anti-inflammatory & gastroprotective properties. Due to its thermogenic nature, capsaicin helps the body in burning off excess calories and enhances your metabolism. Some of the benefits entailed by consuming red chilli in its whole form or powdered form are-enhancement in the metabolism rate, relieve inflammation, aids digestive health, promotes weight loss, supplements cognitive brain function, promotes heart functioning, etc.

The beneficial influence of red pepper or its pungent principle capsaicin on lipid metabolism has been documented by several investigators. Srinivasan *et al.,* (2015) studied the effects of red pepper and capsaicin on fat absorption in rats on a choline-free high hydrogenated fat (40%) diet.It was observed that 5% red pepper or equivalent levels of capsaicin (15 mg) included in the diet had a tendency to lower serum and liver cholesterol levels. An increase in LDL-cholesterol and a reduction in HDL-cholesterol were also observed in the 30% hydrogenated fat group. The oleoresin reduced serum cholesterol and triglycerides as well as liver cholesterol and triglycerides.

Pungency is a key characteristic associated with the genus *Capsicum* and is also an important fruit quality attribute. Reddy *et al.,* (2013) studied onred pepperand found that they are popular food in many parts of the world for their sensory attribute pungency and aroma. Most parts of the world, pungency increases the acceptance of the insipid basic nutrient foods. Red peppers are widely produced and consumed as raw, cooked, or processed products. The consumption of red peppers is mainly due to their pungent flavour (Kumar*et al.,*(2006).

### 2.1. Quality and purity of red pepper

Nutritional content and flavour are important to the perceived value of vegetable crops, but they are not often measured. Horticulturists are particularly interested in evaluating the impact of production system inputs and farming management practices on the quality of plant products such as flowers, fruits, and seeds. In addition, breeders are working to advance experimental lines that have exceptional flavour or high nutritional content from red pepper . Ultimately, these efforts are driven by the goal of increasing the production of high value vegetable crops, which could provide a competitive advantage for growers, especially those selling directly to the end-user such as restaurants or shoppers at a farmers market. Evaluation of sensory qualities that impact consumer preference (e.g., appearance, texture, and flavour) is challenging. Many studies have begun to include on-farm sensory evaluations as an approach to better understand consumer expectations for vegetable quality attributes. While this approach can be successful, consumer focused sensory panels are expensive, in terms of both time and resources, and the information that is collected is relatively subjective limiting their wide-spread use. Thus, there is a need for novel approaches to assess vegetable quality that do not rely on human sensory evaluation. Human perception of overall flavour is influenced by interactions between taste, aroma, mouthfeel, sight, and sound. The chemical composition of non-volatile compounds contributes primarily to taste, whereas volatile compounds reflect aroma. Analysis platforms that can collect qualitative and quantitative chemical data offer a way to objectively characterize vegetable quality attributes that are reflective of the human sensory experience. In addition, these techniques have the added advantage of being able to detect bioactive compounds that cannot be assessed through sensory approaches. For example, p-coumaric acid, an important phenolic compound with suggested beneficial bioactivity, has previously been detected in peppers by mass spectrometry (Mason *et al.,* (2021).

In a study by Soysal*et al.*, (2009), red peppers were evaluated for visual appearance, colour, texture and product acceptability. Visual appearance and product acceptability were evaluated only using hedonic scale. However, colour and texture were evaluated using both intensity and hedonic scales. On the intensity scale for colour, highest values corresponded to deep red colour and lowest corresponded to light bright orange red colour. For the texture intensity, highest corresponded to very crisp and 1owest value corresponded to soft. Recently, multivariate analysis has been used in the sensory evaluation field to reduce the amount of sensory data and classify theoretical and practical subjects (Ku *et al*., (2012). The heat level (hot taste) of the red pepper is mainly due to the capsaicin and dihydrocapsaicin content. Red pepper varieties have a sweet with hot taste and contain a free sugar content of 15～30%, which includes glucose, fructose and sucrose. In contrast, foreign chili peppers commonly have a hot taste and not a sweet taste.

According to the Prasad *et al.,* (2020) redpepper quality depends on their composition, which further depends on factors such as environmental cultivation conditions, variety, ripeness, and pre-harvest and post-harvest handling and preservation. The degree of ripening required may be one of the most important factors in quality, but it will also depend on the destined market, since not the same degree of maturity is desired for all the possible uses. However, the demand and cultivation of peppers, especially "hot" cultivars, has increased due to its flavouring and medicinal properties. Some of the medicinal properties have been described as anticancer, antioxidant and antimicrobial. Its edible and nutritional value is acknowledge as well, since it is rich in vitamins (A, C, B6, E), carotenoids (β-carotene), flavonoids, oils, oleoresins and alkaloids. Therefore, the compounds that can be found in this genre are carbohydrates (accounting for approximately 85% of dry weight), polyphenols (0.5% of dry weight) and important molecules such as capsaicinoids, carotenoids and vitamins.

### 2.2Bioactive compounds of red pepper

**2.2.1. Biological Activity:** C*apsaicin* is the pungent alkaloid of red pepper. Capsaicin is present in large quantities in the placental tissue (which holds the seeds), the internal membranes and, to a lesser extent, the other fleshy parts of the fruits of *Capsicum* plants. The seeds themselves do not produce any capsaicin, although the highest concentration of capsaicin can be found in the white pith of the inner wall, where the seeds are attached. Capsaicin is believed to be synthesized in the interlocular septum of chili peppers by addition of a branched-chain fatty acid to vanillylamine; specifically, capsaicin is made from vanillylamine and 8-methyl-6-nonenoyl Coenzyme-A.

Capsaicin is known for its biological effects which are of high pharmacological relevance. These include cardio protective influence, anti-lithogenic effect, anti-inflammatory and analgesia, thermogenic influence, and beneficial effects on gastrointestinal system. Therefore, capsaicinoids may have the potential clinical value for pain relief, cancer prevention and weight loss (Selvamuthukumaran*et al.*, 2017). Topical application of capsaicin is proved to alleviate pain in arthritis, post-operative neuralgia, diabetic neuropathy, psoriasis, etc. Toxicological studies on capsaicin administered by different routes are documented. Capsaicin inhibits acid secretion, stimulates alkali and mucus secretion and particularly gastric mucosal blood flow which helps in prevention and healing of gastric ulcers. Antioxidant and anti-inflammatory properties of capsaicin are established in a number of studies. The health beneficial hypocholesterolemic influence of capsaicin besides being cardio protective has other implications, viz., prevention of cholesterol gallstones and protection of the structural integrity of erythrocytes under conditions of hypercholesterolemia. Beneficial influences of capsaicin on gastrointestinal system include digestive stimulant action and modulation of intestinal ultra- structure so as to enhance permeability to micronutrients.

Lua*et al.*, (2020) worked on both chemical and biological strategies to study the antioxidant activities of capsaicin. It was found that capsaicin could prevent the redox cycling of iron in rat brain homogenate by binding to ferrous and ferric ion, thus inhibiting the ferrous-induced lipid peroxidation. In-vivo models using obese rats showed that the supplementation of capsaicin and curcumin relieved the testicular and hepatic oxidative stress. The antioxidant defense system was enhanced with increased liver and testis antioxidant enzyme activities, such as glutathione peroxidase and glutathione S-transferase, and protein expressions. In addition to the inhibition effect on lipid peroxidation, capsaicin was also found to protect enzymes and proteins from radiation-induced oxidative damages.

Kim *et al.,* (2003) reported anti-inflamatory characteristics of capsaicin which had been widely used in topical gels and patches as pain-relief treatment. The anti-inflammatory effect of capsaicin was associated with the release of pro-inflammatory mediators. They found that capsaicin suppressed the production of prostaglandin E2 (PGE2) by inhibiting the cyclooxygenase-2 enzyme activity and inducible nitric oxide synthase expression. The study indicated the use of capsaicin for alleviating inflammatory diseases and prostaglandin over production.

According to the Park *et al.,* (2017) studied cancer prevention potential of capsaicin wherein capsaicin exhibited potent anti-carcinogenic effect in various types of human cancers, including gastric cancer, breast cancer, lung cancer, prostate cancer, colorectal cancer, and pancreatic cancer. capsaicin treatment down-regulated the expression levels in human gastric carcinoma cells, leading to apoptosis in gastric cancer. The synergistic effect of capsaicin and camptothecin was reported to induce apoptosis in small cell lung cancer through increasing the intracellular calcium level and calpain activity (A calcium-activated protease).

In a similar study, Zhu *et al.,* (2019) investigated the inhibition effect of capsaicin on prostate cancer stem cells. Results showed that capsaicin suppressed prostate CSCs markers as well as the growth of PC-3 and DU145 prostate CSCs by down-regulating the expression of Wnt-2, p-GSK3β, β-catenin and Wnt/β-catenin pathway target genes c-myc and cyclinD1, indicating that the anti-proliferative effect of capsaicin on prostate cancer cells might be mediated via Wnt/β-catenin pathway. Capsaicin was also reported to display an anti-tumor effect of on colorectal cancer or in short, capsaicin could modulate the expressions level of genes and enzymes involved in cancer cell proliferation, cell cycle arrest, signal transduction, apoptosis and metastasis, therefore demonstrating significant anti-tumor activity.

Satyanarayana (2006) studied on anti-ulcer activity. A common notion that "chilli" is a culprit causing ulcers in view of its irritating nature has turned out to be a "benefactor" as a result of numerous studies. Peptic ulcers in recent years are known to be caused by infection of the stomach with the organism "*Helicobacter Pylori*" which disrupts the normal inhibitory control for acid secretion resulting in excess acid destroying the mucosal barrier. Eradication of the bacteria or re-infection eliminates or restores ulcers. The possibility of excessive intake of capsaicin causes desensitization, eliminating its protective effects resulting in gastritis. The thriving of *H. pylori* in the stomach may also cause gastritis. Persons with this condition are liable to cancer incidence.

**Bioactive compounds*:*** Capsicum species are one of the most consumed vegetables worldwide, mainly due to the diversity of culinary purposes and its handling plasticity. The consumption of both fresh and dry as spice seems to have positive effects on human health. From a nutritional point of view, *Capsicum spp.* fruits are generally considered good sources of most essential nutrients. They are rich in antioxidants, colours, flavour, and vitamins such as Vit A, Vit C, and Vit B complex. The quality of the fruit depends on its chemical composition. Among most important factors that affect composition, environmental and growth conditions, variety, ripeness, maturity, and handling can be found. The total soluble solid content and acidity increases during ripening. The fat, ash, and protein contents are generally higher in red pepper (Melgar-Lalanne *et al.,* 2016).

Capsicum fruits exhibit a high antioxidant activity due to a wide variety of compounds such as phenols, flavonoids, capsaicinoids, and carotenoids. A strong correlation between the presence of bioactive compounds in *Capsicum spp.* and their antioxidant activity evaluated by means of DPPH radical-scavenging has been found. This strong antioxidant activity plays an important role in the prevention of cardiovascular diseases, cancer, and neurological disorders. However, the content and bioavailability depend on the fruit ripening stage and the post-harvesting process, so freezing and boiling process negatively influenced the content of these active compounds (Arslan*et al.,* (2011). Moreover, *Capsicum spp*. oleoresins are rich in bioactive compounds with antimicrobial and antioxidant activities such as carotenoids and capsaicinoids that can be used as a natural additive.

## 2.3. Extraction of bioactive components from red pepper

Dong*et al.,*(2014)showed that *Capsicum*fruit from red pepper have been used for a long time ago in the food industry, in traditional medicine, in agricultural industry and for many other aims. These fruits contain large group of alkaloids capsacinoids, which are characteristic only for the genus *Capsicum.* These alkaloids are responsible for the pungency of red peppers. The great diversity of the genus *Capsicum,* always complicated the taxonomic classification of peppers, and thus the extraction and identification of the exact number of capsaicinoids.Several types of capsaicinoids can be present in the oleoresin extracted from red peppers. A major component of this group is capsaicin (69%). The extraction of the oleoresin from the fruit of red pepper can be made in many ways.One of the most common red pepper products is the pungent *Capsicum* oleoresin that presents an organic oily resin derived from dried ripe fruits of different pungent varieties of *Capsicum annuum L*. by means of solid – liquid extraction. Generally, the most commonly employed and a preferred method for extraction of compounds present in plant matrices is the conventional solid-liquid extraction using organic solvents. In later studies, these conventional methods were improved, modified or rationalized by varying different operating parameters. There are several techniques that can be used for solid – liquid extraction of capsaicin like vacuum filtration, percolation, Soxhlet technique, supercritical fluid extraction etc.

According to the Tolulope*et al.,* (2019)red pigment obtained from dry red pepper is a high-quality natural dye which has anti-cancer and cosmetic properties. *Capsicum* red pigment was extracted in Soxhlet extractor with 95% ethanol. To ensure the optimal extraction process, the temperature ranges were from 30°C to 100°C, with solid-liquid ratio as 1:5 to 1:35, time from 30min up to 150min, and refluxing from once to six times, respectively. Head product was obtained after vacuum distillation and recovered using ethanol. Thepurity of *Capsicum* red pigment was identified by methods of infrared spectrum(IR) and the colour values of the pigment were determined using spectrophotometer. The process was good to extract and purify *capsicum* red dye whose stability was high at neutral and weak acid solution.

Koleva*et al.,* (2013)used methods like vacuum filtration under Soxhlet technique, Pressurized Solvent Extraction and supercritical fluid extraction etc. forextraction of oleoresin form red peppers. The process of extraction under vacuum filtration was made using 0.2 g of grounded pepper in 25 ml of extraction solvent like ethanol. Vacuum filtration was performed for 5 hours at 50ºC.Oumer *et al.,* (2018)also used soxhlet extraction with the ratio of solid-liquid phase as 0.2:25, with 96% ethanol. The extraction was performed for 5 hrs at 80- 85 ºC (ethanol boiling point is 78ºC). Final extracts were diluted in ratio 1: 25. A number of factors determine the final quality of a soxhlet extraction product. Apart from the plant material, most important are time, temperature, pressure, and the quality of the extraction equipment. It comprises very complex products. Each is made up of many, sometimes hundreds, of distinct molecules which come together to form the product’s aroma and therapeutic properties. Some of these molecules are fairly delicate structures which can be altered or destroyed by adverse environmental conditions. It is possible that longer extraction times may give more complete desired product.

Zahra *et al.,* (2016) studied the advantage of soxhlet extraction system and found to be very effective process for extraction of red pepper components. The technique is particularly useful in case when the pure compound is partially soluble in a solvent and the impuritiesare not soluble in the solvent and vice versa. Also, the working principle is so simple that more desired compounds can be obtained without much struggle. It is the most useful apparatus for solid–liquid extraction in various fields such as pharmaceutics and also foodstuffs nowadays.solvent extraction method is that it is a relatively cheap process to operate at a basic level, and the properties of capsaicin produced by this method are not altered. As solvent reduces the boiling point of a particular component of the capsaicin, it never decomposes in this method. This method apart from being economical, it is also relatively faster than other methods.

Pressurized liquid extraction (PLE) is similar to Soxhlet extraction, except that during the extraction process the solvent condition inside the PLE cell approaches the supercritical region which results in more efficient extractions. Gerardo *et al.*, (2006) used pressurized liquid extraction (PLE) or pressurized fluid extraction (PFE) as a sample extraction method that employs liquid solvents at elevated temperatures and pressures to prepare samples for analysis by either gas chromatography or liquid chromatography.The elevated temperature allows the sample to become more soluble and achieve a higher diffusion rate while the elevated pressure keeps the solvent below its boiling point. At elevated pressures and temperatures, solvents can penetrate solid samples more efficiently which reduces solvent usage.

In food products, use of supercritical fluids is essentially limited to supercritical carbon dioxide (SCF-$CO_2$) extraction since carbon dioxide has the advantages of being inexpensive and nontoxic and because its critical point is easily reached.Romo-Hualde*et al.,* (2012)also conducted a study on Supercritical fluid extraction (SFE) from red pepper by-products, studying different parameters that affect the yield.Seliem*et al.,* (2015) studied supercritical fluid $CO_2$ extraction from oleoresin extracted from low grade grapes and red pepper at 40°C and 350 bar pressure until no significant amount of extracted oleoresin could be collected.

Krithika*et al.,*(2014) studied on microencapsulation of the synthetic vitamins and red pepper extract by emulsion followed by a drying process. The emulsion was spray dried using organic solvents. Synthetic vitamin E and provitamin A were used to optimise the microencapsulation process and compared to microencapsulated natural red pepper extract.

Dang *et al.,* (2014) determined the extraction of capsanthin and capsaicin from red pepper using a three-liquid-phase system (TLPS) of acetone/$K_2HPO_4$ /n-hexane. When the system consisted of 22% (w/w) acetone/20% (w/w) $K_2HPO_4$ /10% (w/w) n-hexane, capsanthin was extracted into the top n-hexane-rich phase, yielding a recovery of 98.15% at a temperature of 25°C. The yields of capsanthin and capsaicin were 105% and 88% of those of the conventional solvent extraction, respectively. Thus, capsanthin and capsaicin were separated through a single step at a low cost.

**2.4. Applicationsof red pepper in Food industry**

*Capsicum* oleoresin is essentially the integral of pungent priciples, pigments, fixed oils, resins and waxes. Oleoresin encompasses the aroma, taste and colour components of the spice in the most concentrated form. Hence, oleoresin represents true essence of the spice and serves as the standardised, hygienic and convenient substitute for raw spice in food applications (Balakrishnan*et al.,* (1996). Moreover, the quality parameters of the oleoresin could be standardised to any level to meet specific customer requirements.

Nurjanah*et al.,*(2006)studied the characterization of oleoresin from red big chilli and curly chilli, using whole chilli and without seed chilli.Chilli oleoresin was made through the process of drying of whole chillies, size reduction followed by extraction using solvent and evaporation of the solvent. There were different number of oleoresin in the pulp and seed of chilli, so it was required to study the oleoresin of whole chilli and chilli without seed.

Oher applications of Chilli oleoresins are 1) flavouring agents, due to the pungent effect it is used to provide flavour in food products; 2)as colouring agents,for colouring of food, eatables and medicines is common application where chilli oleoresin gives a range of red colour; 3)for manufacture of sprays for safety, it is used in making safety gear for girls and can make a person blind for few minutes; and 4)as preservatives,capsaicinoids help to preserve the meet and other food items against microbial activity.

**2.5 Packaging, storage and shelf- life of red pepper.**

Khobragade*et at.,* (2018) studies onspices play an important role in enhancing the flavour and taste of the processed foods. On account of their ability to impart flavour and aroma, spices have been used in the preparation of a wide variety of processed foods. Red pepper is an important spice crop and India is one of the leading producer and exporter of red pepper in the world. Red pepper is widely used around the world in food as a spice, both in fresh and dried form that adds flavour to the meal by creating spicy and pungent taste. Powdered spices are convenient to use and also save time and energy for preparing different delicious dishes. Besides their everyday use in households, spices are used in significant quantities in processed foods such as pickles and sauces. Therefore, the necessary information regarding different processing characteristics, processing practices, packaging and storage of red peppercarried out studies to design a suitable consumer size package from flexible packaging material to hold 100 g of chilli powder. From the packaging and storage studies of red pepper powder in different flexible films, it can be concluded that for long-term storage, the aluminium foil laminate is unique in offering maximum protection from various physicochemical changes. For short-term storage and for fairly good moisture and colour protection, amber or black polyethylene, high-density polyethylene and Saran/Cello/Saran poly laminate pouches appear to be suitable alternatives.

Gobie*et at.,* (2019) conducted a study onpackaging is an important part of product processing and preservation and has direct influence on the system in respect to physical and chemical changes. Plastic materials are used very widely for food packaging application because of their obvious advantages of being light in weight, having good productivity, can be manufactured into a number of forms and shape and being recyclable. Storage under nitrogen gave the best extension of shelf life. Adding vitamin E also extended shelf life. Addition of seed oil produced a rancid odour and did not reduce colour loss found that packaging plays an important role in determining the stability of foods by influencing those factors which cause or contribute to food deterioration during storage. The nature of a package determines the composition of air inside the package, which in turn is known to affect the rate and extent of nutrient loss and microbial activity among other things reported that the overall decomposition rate of pigment was dependent on the storage time and on the presence of light and oxygen, the effect of storage time being the most decisive factor, while the impact of oxygen was thefound that the packaging material plays a fundamental role in maintaining the quality and shelf life of foods items. The package is an integral part of the preservation system and functions as an interfacebetween the food and the external environment; the package should be designed and developed not only to contain the food product but also to protect it and add value to it, as its design may directly affect the purchase decision of the consumerconducted the experiment to evaluate the effect of packaging materials.

Samira *et al.,* (2013) the study ofstorage conditions on maintain the moisture content of 10 to 11% with subsequent storage at -16°C was shown to be the best with minimum colour loss in ground *capsicum.* According to the studies conducted by the moisture content of the chilli powder appeared to be critical (around 10%) for colour retention during storage. Lower level of moisture lead to the colour bleach while at higher levels there was darkening by browning reactions but there was no change in carotenoid content found that the colour deterioration was lower athigh moisture contents (10-14%) with corresponding water activity values of 0.4 to 0.6. High moisture content of 18% resulted in microbial growth, non-enzymatic browning and caking. That spices deteriorate rapidly under adverse conditions and should be stored in well maintained storage facilities. It is essential that the moisture level of the spice to be stored is at a safe level, usually below 10% moisture to ensure storage without mold growth.

Storage temperature that refrigerated storage at 5°C slowed down the deterioration of colour. Storage temperature was found to have greater effect on the colour stability of the pepper than did light, the kind of container or whether the pepper was stored as whole or ground. That storage at higher temperature increased the rate of colour destruction and resulted in blackening of whole chillies. This deterioration of colour was also ascribed to non-enzymatic browning accentuated by both the moisture and ambient temperature. According to powders from two paprika cultivars and one chilli was stored in air at 37°C in the dark for accelerated shelf- life testing. Chilli powder needs to be stored under cool conditions and out of light. The commercial hammer mill produce a powder of equal quality to stone milled product. Found that the colour change of red pepper powder was greatly dependent on temperature and water activity. As temperature and water activity increased, red colour of pepper powder increasingly faded out to become brown and tarnish black, which is mainly attributed to the degradation of carotenoid pigments and development of browning compound. Topuz*et al.,* (2004)This study indicated that; increase the shelf-life of red pepperand technology were used the dehydration process may be more preferable than the sun drying process. This may be due to the faster drying rate, which restricts peroxidase activity.In terms of both capsaicin and dihydro-capsaicin, there were relationships between the drying method and storage stability. Changes in the amounts of these principal pungent components were less in the dehydrated red pepper during storage, whereas they changed not sun-dried red pepper after 2 months of storage.

## III. CONCLUSION

Red pepperis an important vegetable crop and it is the most produced type of spice for providing flavouring and colour to food along with essential vitamins and minerals. Red pepper are good source for the production of anti- oxidant enzymes and may have a potential industrial, agriculturalapplications. The nutritional and medicinal quality gives it an extra importance. Red pepper contains high amount of vitamin C and other vitamins such as vitamin A, vitamin B6, vitamin K and minerals like calcium, magnesium, folate, potassium, thiamin, iron, copper etc.Pepper bioactive compounds, vitamins and minerals serve as health promoters.Capsaicin is the main bioactive compound in pepper, responsible for its pungent taste and various health benefits.*Capsicum* oleoresin and purified extracts are rich in carotenoids and capsaicinoids. An increased demand in oleoresins and other natural products for taste improvement and trade qualities of food products has been observed. Special interest is paid to paprika oleoresins. They all contain valuable fat-soluble components such as pigments, flavours and taste agents, vitamins and fatty oil in the seed of paprika fruits.

Red pepper has diverse uses in pharmaceuticals that are attributed to relief of pain, anti-arthritic, anti-bacterial, anti-inflammatory, anti-rhinitis, and analgesic properties. It has also prominent role as an immunity booster for the management of cardiovascular diseases, diabetes, obesity and stops the spread of prostate cancer. The consumption of red pepper is reported to be related with reduced mortality rate in human being.

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