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Stability of plant and animal vitamins with new non-thermal methods

Sepideh Mohammadi
Master student of Food Industry Engineering (Food Technology)Islamic Azad University, Rasht Branch, Gilan, Iran
Sepidehmohammadi_sm@yahoo.com

Abstract
Vitamins are organic substances that are needed in limited quantities and play a certain metabolic role and must be available to the body through the food consumed. Any food that has been intentionally altered before consumption is processed, and since many vitamins are unstable under certain processing and storage conditions, therefore; This change sometimes causes the levels of vitamins in processed foods to decrease significantly . This necessitates the study of new methods of food processing on their shelf life. New food processing methods such as osmotic drying, pulsed electric field process, high pressure, vacuum cooling, and others have been used to maintain food quality in recent years.
It is hoped that these new non-thermal methods can improve the durability and stability of vitamins.

Keywords: Vitamin, Non-thermal method, Plant and animal foods, Stability

Introduction

One of the goals of food manufacturers is to develop and use technologies that maintain or produce desirable sensory and qualitative properties or reduce adverse process changes .The use of physical protection methods (heating, freezing, dehydration, drying or packaging) or chemical (such as lowering the pH or using chemical preservatives) continues And technological advances are being made rapidly to improve the efficiency of these processes .The basis of these traditional and common methods is to reduce microbial growth and inhibit metabolism to prevent undesirable chemical changes in food. The most common food preservation methods used today are heat treatments (pasteurization and sterilization). Although heating food effectively reduces the amount of microorganisms, including pathogenic bacteria, such processes can also alter the nature of the taste of food and destroy vitamins.Thus, new technologies are emerging that help advance safety, fresh-tasting foods, and preservation of nutrients without the use of heat or chemical preservatives. These non-thermal processes for food protection have been considered by many food manufacturers today (Hogan et al. 2005).

Much research has been done on non-thermal methods of food preservation to investigate the possibility of using them as an alternative to or complementary to conventional methods.

Non-thermal processes such as high pressure technology, strong pulsed electric fields, the use of radiation and ultrasound have been developing in recent decades with the ultimate goal of using them in industry. Each technology has its own principles of action and in different food fields can have very different and unpredictable effects. However, among these technologies, high pressure treatment and radiation use have recently been used more commercially (Olio et al. 2012).

Although these technologies have been used for a long time to inactivate microorganisms or food preservation, but they have been identified as non-thermal methods of food preservation in recent years (Mortazavi et al., 2002).

vitamins

Vitamins are fundamentally different in terms of solubility .This means that some

are soluble in fat and some in water. This difference is the basis for dividing vitamins into two groups: water-soluble vitamins and fat-soluble vitamins (Fatemi, 2020).
From this simple classification of vitamins, a group consisting of four different fat-soluble vitamins (vitamins A, D, K, and E) and eleven water-soluble substances, such as vitamin B complex and vitamin C, emerged.With increasing information on the physical and chemical properties and physiological role of vitamins, and to the extent that the role of each B-complex vitamin is elucidated, efforts have been made to avoid assigning titles such as B1, B2, and B6 that represent a general role or biochemical relationship. Be.At present there is no direct correlation, except that all are soluble in water and most of them act as coenzymes in metabolic reactions.Words that are mostly dedicated to their composition or structure, such as thiamine, riboflavin, pyridoxine, folacin and cobalamin are used (Forouzani, 2002).

The effect of vitamins in the body

A) As a coenzyme with their related compounds (niacin, thiamine, riboflavin, biotin, pantothenic acid, vitamins B6, B12 and folate)
B) As antioxidant compounds (ascorbic acid, special carotenoids and vitamin E)
D) as factors involved in genetic regulation (vitamin A)
Ii) Use in specific applications such as vitamin A in vision, ascorbate in multiple hydroxylation reactions, and vitamin K in blood coagulation (Gregory, 1996).

Daily body needs for vitamins:

Table 1- Recommended amounts needed to consume vitamins per day (Fatemi, 2020)

Vitamins	**Men**	**Women**	**Children (Less than 11 years)**
Fat soluble			
Vitamin A (retinol, micrograms)	1000	800	400-700
Vitamin D (total calciferol, micrograms)	5-10	5-10	10
Vitamin E (alpha tocopherol, mg)	10	8	6-7
Vitamin K (micrograms)	45-80	45-46	15-30
Water soluble			
Vitamin C (mg)	60	60	40-45
Vitamin B1 (thiamine, mg)	1/5	1/5	0/7-1
Vitamin B2 (riboflavin, mg)	1/7	1/3	0/8-1/2
Vitamin B6 (pyridoxine, mg)	2	1/6	1-1/4
Vitamin B12 (micrograms)	2	2	0/7-1/4
Niacin (mg)	19	15	9-13
Folic acid (micrograms)	200	180	50-100

Stability of vitamins

Vitamins make up a very small amount of food in quantity. In terms of food chemistry, it usually tries to maximize the shelf life of vitamins in food by minimizing physical changes (water extraction or leaching) and chemical changes (oxidation and reaction with other nutrients). Many vitamins, on the other hand, affect the chemical nature of food by acting as reducing agents, radicals, reactants in browning reactions, and specific flavors (Combs, 1992).
Chemical systems (often buffer solutions) are used in many studies to evaluate the stability of vitamins to simplify research on the stability of vitamins. The results of these studies must be interpreted with great

dependent on compounds that exhibit similar nutritional performance, and the presence of these groups poses a major limitation in the attempt to evaluate the stability of vitamins between different forms of each vitamin.

Multiple forms of each vitamin can exhibit different reactivity and stability (in terms of optimal pH, stability, and ability to oxidize) (Gregory, 1996).

For example, tetrahydrofolic acid and folic acid are two folate that have almost the same nutritional properties. Tetrahydrofolic (natural form) is highly susceptible to oxidative degradation, while folic acid (a synthetic form used in food enrichment) is more stable to oxidation (Higdon and Derek, 2012).

However, many vitamins are unstable under processing and storage conditions. Table 2 summarizes the stability of vitamins under different conditions.

Table 2 - Stability of vitamins in different conditions (Gregory, 1996)

Maximum dissipation in cooking (٪)	Heat	light	Air or oxygen	Alkaline	Neutral	Acidic	Vitamin
40	u	u	u	s	s	u	Vitamin A
100	u	u	u	u	u	s	Ascorbic acid
60	u	s	s	s	s	s	Biotin
30	u	u	u	s	s	u	Carotene
5	s	s	u	s	s	s	kolin
10	s	u	u	s	s	s	Vitamin B12
40	u	u	u	u	s	s	Vitamin D
100	u	u	u	u	u	u	Folate
5	s	u	s	u	s	u	Vitamin K
75	s	s	s	s	s	s	Niasin
50	s	s	s	u	s	u	Pantothenic acid
40	u	u	s	s	s	s	Vitamin B6
75	u	u	s	u	s	u	Riboflavin
80	u	s	u	u	u	u	Thiamine
55	u	u	u	s	s	s	Tocopherol

Stable: s
Unstable :u

Vitamin A

Vitamin A belongs to a group of polyunsaturated hydrocarbons with important nutritional patterns in humans.The most important compounds in this group are retinoids, which are chemical derivatives of retinol, and the precursor carotenoids of vitamin A are converted to retinoids in vivo. This vitamin is a pale yellow substance that is soluble in fat or fat-soluble solutions. Vitamin A is necessary for growth in childhood, and this is due to its role in vision and visual health, the development of the immune system and its nervous systems. Vitamin A deficiency is one of the leading causes of death in developing countries, especially among mothers and infants (Loveda and Singh, 2008).

Most of this vitamin is found in the liver oil of special fish such as tuna and cod . Other major sources of this vitamin are liver, egg yolks, milk and dairy products. Spinach exceptionally contains some pre-made vitamin A that is biologically active (Saovant et al, 2011).

Vitamin A is resistant to heat and alkalis and unstable to light, acids and oxidation conditions. Some vitamins are lost under normal food conditions. High temperatures in carotene-rich frying oils, such as palm oil, which are widely used in the tropics, may cause their destruction, similar to the oxidation that occurs in rotten fats. The small amount of yellow and green pigments that may appear in the cooking water of fruits and vegetables represent only a small part of what is in the food. Sun-dried fruits and other forms of dehydration can lead to the loss of some of the vitamin A. The results of nutritional studies have shown that vitamin A is a nutrient that is often consumed less than the recommended amount and its level in the blood is often less than expected (Forouzani, 2002).

All-trans retinols have the maximum activity of vitamin A but are isomerized during the food preservation process. Oxygen accelerates the degradation of light-catalyzed retinoids under certain conditions, but degradation in the presence of oxygen is relatively slow without the presence of catalysts such as light or produced radicals .Degradation of vitamin A in food is accelerated by exposure to light, especially ultraviolet light, at wavelengths below 415 nm. In this case, the destruction of vitamin A by ultraviolet A rays is faster than that of B ultraviolet rays (Loveda and Singh, 2008).

Vitamin E

Vitamin E is found in foods in the form of alpha, beta, gamma and delta tocopherols. Vitamin E was first obtained from wheat germ oil .In general, the amount of vitamins in oils increases with increasing polyunsaturated fatty acids. Oxidative treatments such as bleaching (flour bleaching) cause a major loss of vitamin E (Gregory, 1996).

Processes such as frying and then storage at normal temperatures can cause a major loss of this vitamin. Baking vegetables in water and baking white bread also causes a percentage of mecca loss of this vitamin (Deman, 1999).

Vitamin D

This vitamin is available in different forms, the two main forms of which are vitamin D2 or ergocalciferol and vitamin D3 or cholecalciferol.Vitamin D is an essential factor for normal bone and mineral metabolism. The effect of vitamin D deficiency has been cited as the cause of metabolic bone diseases such as rickets, osteoporosis, osteoporosis, and finally weakness and loss of bone mass. Recent studies show the effect of deficiency of this vitamin in reducing the immune system, reducing the strength of pregnancy, reducing the insulin response to glucose, reducing the contraction of the heart and increasing blood pressure (Larijani et al., 2003).

Vitamin D is not present in plant products. Vitamin D2 is found in very small amounts in fish liver oil. Vitamin D3 is widely found in animal products but is abundant in fish liver oil. Eggs, milk, butter and cheese contain less of this vitamin (Deman, 1999).

Eating foods fortified with vitamin D is common during periods when the need for this vitamin increases. Milk is the only product approved for fortification with this vitamin. But it is added to other products such as breakfast cereals, margarine and even beverages (Forouzani, 2002).

Vitamin D is very stable and under the same conditions of processing and storage, the slightest change occurs .Vitamin D in milk is not affected by pasteurization, cooking and sterilization. Freezing of milk, dry milk and butter has a certain amount on it (Deman, 1999).

Vitamin D is sensitive to degradation by light and may be present in bottled milk during storage during retail. For example, 50% of Calciferol added to milk is lost during 12 days after continuous exposure to fluorescent light at 4 ° C. It is not known whether this degradation involved direct photochemical degradation or as an indirect effect of light on lipid oxidation. Like other fat-soluble components of food, vitamin D is sensitive to oxidative degradation, but it is still stable in food, especially not under major anaerobic conditions (Gregory, 1996).

Vitamin C

Vitamin C or ascorbic acid is present in all living tissues and affects oxidation and reduction reactions. This vitamin is a lactone, that is, it is produced within the molecule by the reaction of esterification through the reaction between the carboxyl group and the hydroxyl group. Vitamin C is found exclusively in plant foods. Except for liver, no other animal food is a significant source of vitamin C. (Deman, 1999).

One of these factors is the type and different parts of the plant. For example, the head area of broccoli has about 158 mg per 100 g, while the stem contains 115 mg per 100 g of vitamin C.

But the stem retains 82% and the plant head 60% of the vitamin within 10 minutes of cooking. Thin stems have more vitamin C than thick stems. Remaining and withered plants lose more vitamin C than fresh and succulent plants. The root slowly loses vitamin C, but when the temperature rises, the rate of loss increases. This is because vitamin C accumulates in the fruit gradually or as the fruit ripens in its place. Therefore, the more fruit remains on the tree, the more ascorbic acid it will contain (Forouzani, 2002).

Due to the high solubility of ascorbic acid in aqueous solutions, this compound can be leached from freshly cut fruits or ground surfaces of fruits and vegetables by leaching, which can be reduced in the food in addition to being soluble in various factors such as the type of substance. The food depends on the type of food, the method of preparation, the method and the cooking time. This vitamin is sensitive to oxidation and heat and is used as an indicator to determine the intensity of processing or cooking method (determining the quality of food) (Weiss and Mohammadi, 2010).

Chemical degradation of this vitamin initially involves oxidation to dehydroascorbic acid and then hydrolysis to 3,2-dicetlucluconic acid and subsequent oxidation, dehydration, and polymerization to produce a wide range of inactive products. The main factors affecting the speed, mechanism and nature of ascorbic acid products are pH, oxygen concentration and the presence of metal catalysts. The rate of oxidative degradation of vitamin C is a nonlinear function of pH due to different ionic forms of ascorbic acid that have different sensitivity to oxidation (Gregory, 1996).

Vitamin B1 (thiamine)

This vitamin participates in the metabolism of carbohydrates and decarboxylation of alpha-keto acids as a coenzyme, which in this case acts in combination with phosphoric acid or thiamine pyrophosphate, and in this regard is also called cocarboxylase. Thiamine is not phosphorylated in vegetables, while in meat it is mostly in the form of diphosphate or carboxylase, which must be separated before absorption (Foruzani, 2002).

The main sources of this vitamin are in whole grains, in various organs such as liver, heart and kidneys, seeds and potatoes. A large amount of thiamine in cereals accumulates in its outer shell and is the same shell that is lost in the grinding of cereals. Fortified bread or whole wheat bread is a significant source of thiamine (Deman, 1999).

Chickpeas and other legumes are also significant sources of this vitamin. In chickpeas, the amount of thiamine increases with the ripening of chickpea seeds. Therefore, dried chickpeas have more thiamine than fresh chickpeas. Soaking dried peas in water for a long time and discarding this water or using soda to facilitate softening of the pea skin will cause some thiamine to be lost. Dry brewer's yeast and wheat germ are both sources of thiamine. In enriching other cereal products such as rice, pasta, corn and flour, attention should be paid to which is the main food of a society (Forouzani, 2002).

Thiamine loss from food is noticeable when the aquatic environment causes thiamine to be leached out. Approximately neutral or higher pH or exposure to sulfurizing agents occurs. Thiamine loss also occurs in hydrated foods at moderate temperatures, at a slower rate than during the thermal process (Mauri et al, 1989).

Thiamine shows very good stability at ambient temperature under conditions of low water activity. In dehydrated models (similar to breakfast cereals) at temperatures below 37 ° C and water activity between 0.1 to 0.65 did not show any loss or slight loss. In contrast, it decomposes rapidly at 45 ° C in aqueous activity of 0.4 or higher. In this model system, the highest rate of degradation in water activity occurs between 0.5 and 0.65. In similar model systems, the rate of thiamine degradation increases with increasing water activity from 0.65 to 0.85 (Arabshahi, 2010).

Thiamine is unstable in many fish and seafood due to the presence of the enzyme thiaminease. However, at least part of this thiamine degradation activity is caused by iron-containing proteins (globin and hemoglobin), which are non-enzymatic heat-resistant catalysts. There are other compounds in food that affect the stability of thiamine. Tannins can apparently destroy thiamine by forming several biologically inactive additives. Different flavonoids can change thiamine, but the product of flavonoid oxidation in the presence of thiamine is a thiamine disulfide that has thiamine activity. Carbohydrates can reduce the rate of thiamine degradation during heating or in the presence of bisulfite, although this effect is difficult to predict in complex food systems (Gregory, 1996).

New non-thermal methods

1- High hydrostatic pressure process

In the search for new process methods, especially for special products, the application of high pressure process has considerable potential as a technology for thermal treatments, in terms of quality assurance and attention to quality characteristics in food products has been minimized.

Consumer demand for processed food products is currently a challenge for food processors (Hogan et al. 2005).

While food safety and shelf life often depend on microbial quality, other phenomena such as enzymatic reactions and structural changes can significantly affect the quality desired by the consumer. Conventional thermal processes include slow thermal penetration that extends to the center (cold point) of the product and subsequent cooling. This thermal process involves changes in quality that are largely dependent on the product being treated and the temperatures used. These changes include the production of unpleasant odors, soft tissues, as well as the destruction of vitamins and dyes. Unlike heat, the use of medium pressure treatment does not change the sensory and qualitative properties of food. Thus, this process is a technology in the food industry that can create heat-treated safety properties, while maintaining consumer demand for fresher foods. High pressure process Sometimes referred to as high hydrostatic pressure is a relatively new non-thermal process that takes place on solid or liquid foods, with or without packaging, under a pressure of 50 to 1000 MPa. Extensive research is underway into the potential benefits of the high pressure process as an alternative to thermal processes. These benefits are in various areas of the food process, such as inactivation of microorganisms and enzymes, denaturation of functional proteins, and structural changes to food (Hogan et al. 2005).

High hydrostatic pressure is used to inactivate microorganisms, some enzymes, and to extend the shelf life of food. At high pressure, germination of spores intensifies, but high temperatures inactivate germinated spores. Applications of high pressure technology include modifying the textural and sensory properties of food, crushing beef before freezing the corpse, making surimi jelly, producing jam puree and strawberry jelly, producing marmalade from orange and extending the shelf life of milk. One of the most important problems in the use of high pressure technology is the construction of pipes and stitches that can withstand high pressures while applying pressure and removing it (Mortazavi et al., 2002).

This process is done in the food industry in two ways: continuous and non-continuous system. The commercial use of the high pressure process is increasing, there are opportunities for new applications and advances in the production of food products in this field, and high pressure can affect the use of protein molecules and carbohydrates in unique ways and the possibility of producing products. Provide modern food. Currently, the number of products that are commercially produced by this treatment is small. But there are many opportunities to expand the production of a wide range of products with this treatment in the future. This technology involves applying uniform pressure across a product. In the food industry, the isostatic pressure technique is used to apply pressure. Isostatic pressure systems exist in three forms: cold isostatic systems, hot isostatic or hot isostatic (Mortazavi et al., 2002).

The biggest problem with high pressure treatment in solid foods is the use of discontinuous or semi-continuous processes and the high cost of high pressure pipes. This environmentally friendly process is a new technology with the capability of industrialization that can be a substitute for the usual process of a wide range of different food products. This method prolongs the shelf life of the mani. At the same time as the microorganisms and enzymes are inactivated, the organoleptic quality is preserved and small molecules such as flavor molecules and vitamins remain intact. This technology has many advantages, especially for high value-added food products, targeted at a growing group of consumers who demand the highest level of safety and quality in purchased products (Hogan et al. 2005).

In plant products, although it is not yet possible to use this process in some products, such as salads, in the United States and Europe it is an alternative to pasteurizing ready meals and sauces. Pressures above 600 MPa can inactivate yeasts, fungi, and gram-positive bacteria (including pathogens), while keeping small molecules such as vitamins intact.

Because vegetables are a rich source of these substances, this process is especially important for the preservation of vitamins (Panderangi and Braminian, 2005).

Many authors have reported that vitamin C in products made from vegetables and fruits is not significantly affected by the high-pressure process. It has been reported that the persistence of ascorbic acid in orange juice after treatment with high pressure at 400 MPa was 40% and the duration of ten minutes was 91%. The loss of vitamin C in vegetable-based beverages after high-pressure treatment (100, 200, 300 and 400 MPa) at different times used did not exceed a small amount compared to heat treatments (Barba et al., 2010).

Studies on tomato juice have shown that the process of high pressure (300 to 500 MPa) and storage for 28 days at 4 ° C can preserve vitamin C better than thermal processes and the loss of this vitamin after treatment High pressure usually depends on the intensity of temperature and time used in the process (Hsu et al., 2008.(

In one study, the effect of three pressure levels (300, 400 and 500 MPa) on quality characteristics including vitamins E and C in aloe vera gel was evaluated .The results showed that high hydrostatic pressure had no significant effect on the amount of these vitamins. After 35 days of storage, a decrease in the amount of these two vitamins was observed in all stored and treated samples with a pressure of 500 MPa (Galvez et al., 2011).

The tendency to use high pressure in milk and dairy products is also growing recently .Pressures between 300 and 600 MPa are an effective way to inactivate microorganisms that contain most food pathogens. In addition to microbial degradation, it has been reported that high pressure rennet improves the acid or coagulation of milk without a destructive effect on important quality properties such as taste and vitamins. Unlike thermal treatments that affect covalent and non-covalent bonds, high pressure treatment at room temperature or mild temperatures removes only weak chemical bonds such as hydrogen bonds, hydrophobic bonds, and ionic bonds. Therefore, small molecules such as vitamins and amino acids and flavor compounds remain unchanged by this treatment. High-pressure treatment at 400 MPa for 30 minutes at 25 ° C at a rate of 2.5 MPa / s did not cause any significant reduction in milk vitamins B6 and B1 (Trujillo et al., 2002).

Multivitamin systems include varying levels of water-soluble vitamins such as ascorbic acid, thiamine and vitamin B6 (peridoxal) and food systems (egg yolks) containing normal levels of vitamin C under pressure in the range of 200 to 600 MPa for 30 minutes to determine The effect of this process on vitamins was studied. In the model system, the loss and reduction of vitamin C was about 12%, while in the food model, this reduction was not significant. Compared to the normal sterilization process, high-pressure treatments retain vitamins better.

Thiamine and peridoxal were not affected by high pressure in the model system. This study confirms the fact that the high blood pressure process has the least effect on nutrients, including vitamins (Sancho et al., 1999).

2- Strong pulsed electric fields

Pulsed electric fields (PEFs) are a new technology that can be used as an alternative to inactivating microorganisms and enzymes in liquid foods such as milk thistle. It has a better energy range compared to thermal processes. In this technology, an electric field is used in a short time efficiency on the flow of liquid food between the two electrodes. Extensive studies have been conducted on the development of this process in the food industry since 1990 (Shamsi et al., 2009).

The application of the strong pulsed electric field process as a membrane permeability technique has received more attention in the food process in recent decades. Among the new technologies, its application is one of the most advanced process methods. Low process temperature and short time can effectively inactivate microorganisms and at the same time maintain product quality. The ability to penetrate cellular tissue in the short term can be used as an alternative to energy and long term in conventional methods, mechanical methods or enzymatic processes. Increasing consumer demand for foods with high nutritional value and similar taste to fresh foods has led to the development of gentle processes and alternatives to common techniques such as heat treatments. The use of an external electric field over a period of microseconds causes local and structural changes in a rapid cell membrane breakdown. This phenomenon is called electroporation.

The use of high intensity pulsed electric fields can be used to inactivate microorganisms by irreversible destruction of the cell wall. In the food industry, this irreversible formation of cell wall pores can be used to inactivate microorganisms. This irreversible process can be used as a gentle preservative technique for liquid foods, as well as as an alternative to conventional cell degradation methods such as milling or enzymatic treatment as a pretreatment to improve transfer before drying, pressure extraction. The inactivation of microorganisms by pulsed electric fields depends on several factors, the most important of which are the intensity of the electric field current, the processing time, the temperature of the food and the type of microorganism. The rate of inactivation of microorganisms increases with increasing electric field strength, contact time, and food temperature. Of course, it is better to keep the temperature below 30 to 40 degrees Celsius by considering a cooling system. Different bacteria have different sensitivities to the electric field. In general, gram-positive bacteria and yeasts are more resistant than gram-negative bacteria. The optimal conditions for achieving the maximum rate of inactivation of a particular microorganism are determined after initial experiments (Mortazavi et al., 2002).

Vitamin C is more important than other bioactive compounds when evaluating the effects of non-thermal processes. Many studies have been done on the effect of strong pulsed electric fields on vitamins. It has been reported that this treatment has very little effect on the amount of vitamins. The shelf life of vitamin C depends on factors such as electric field strength, treatment time, and pulse frequency in juices processed by this treatment (Fortuny et al., 2009) such as orange juice (Martinez et al., 2007), apple (Erle et al. 2000), tomatoes, watermelons, strawberries, and other vegetable-based beverages have been observed in the range of 50 to 99% (Serrano et al., 2008).

Recent studies on a higher stability of carotenoids by storage in products processed by pulsed electric field compared to equivalent heat treatment. Improvement of stability and shelf life of an orange milk drink obtained by process under conditions of 280 microseconds and 25 kW / cm was observed compared to heat treatment of 90 ° C and 20 s (Zulota et al., 2010).

The nutritional properties of food stored in the refrigerator, processed by new high-pressure technologies and strong pulsed electric fields, are also necessary compared to conventional thermal methods. In a study, fresh orange juice was treated with high pressure (400 MPa, 40 ° C per minute) and strong pulsed electric fields (35 kW / 750 μs) and pasteurization at low temperature (70 ° C at 30 ° C). Seconds) was processed. The stability of vitamin C was evaluated after treatments and during 40 days of refrigeration at 4 ° C. Shortly after treatment, all treated specimens showed a less than 8% reduction in vitamin C content compared to untreated specimens. At the end of the refrigeration period, high-pressure and pasteurized processed samples showed similar vitamin C loss, which was lower than that of pulsed-treated samples. But on longer storage days, the high-pressure process resulted in better shelf life of vitamin C than heat-pasteurized juices (Plaza et al., 2006).

In another study, the potential of using PEF to reduce the number of Salmonella bacteria in orange juice and its bactericidal effect was used, using an electric field of 80 kW / cm at pH = 3.5 and a temperature of 44 ° C. The retention rate of vitamin C was about 97.5% (Metal and Griffiths, 2005).

Much research on PEF has been done on milk and dairy products. Most of these studies have examined the effect of PEF on the inactivation of microorganisms. The effects of PEF on milk vitamins have also been studied. PEF, as a non-thermal process, retains the natural composition of milk. If trace amounts such as vitamins are preserved in this technique, it can be produced in the dairy industry as products with excellent nutritional composition and normal sensory quality. To evaluate the effect of PEF on milk vitamins, Bandicho et al. Power fields ranged from 18.3 to 22.1 kW / cm. No changes in the amount of these vitamins were observed except for ascorbic acid. The shelf life of this vitamin at a power of 22.6 kW / cm for 400 microseconds was 93.4%, which is 49.7% after low-temperature thermal pasteurization treatments (63 ° C in 30 minutes) and 49% in the pasteurization process. High and short time (75 ° C in 15 seconds) was 86.7% and indicates that the amount of vitamin reduction with this treatment was much less (Bandicho et al., 2002).

3- Radiation

Food is usually irradiated with gamma rays and through a radioisotope source, electrons or X-rays produced through an electron accelerator. The use of radiation is a new and promising technology for cleaning and sanitizing food that can be applied to the final product. This technology has advantages that can be used for frozen, fresh or cooked food. This technology is physical, safe, environmentally friendly and efficient. The presence of parasites, some microorganisms, yeasts and molds are major sources of problems in food that cause a lot of waste directly or through the production of toxins in food products. Radiation alone or in combination with other processes can contribute to the safety and health of high-risk consumer foods, quarantine requirements, and the control of severe waste in transportation and commercial matters (Lycroys, 2005).

In irradiation, the food is exposed to radiation with an energy of 5 to 10 kg and a wavelength of 2000 angstrom or less. The wavelengths of ultraviolet, beta, gamma, x and microwave radiation are in this range. One of the benefits of radiation is its ability to pasteurize frozen foods. The World Health Organization considers the 10 kg dose unconditionally safe for humans. The use of radiation to make food healthier is legal in at least 43 countries, including the United States. Applications of irradiation include extending the shelf life of root crops, disinfecting spices, fruits and cereals, delaying fruit ripening, improving the sensory properties of food, and sterilizing aseptic packaging containers. Also, radiation can be easily replaced by many dangerous pesticides and chemical preservatives (Mortazavi et al., 2002).

Meats, vegetables, and fruits are good for radiation because radiation causes fat to begin to oxidize and later to spread stench in oils, dairy products, and eggs. Vitamins Some proteins are derived from other food components, including the interaction of vitamins. Irradiation of pork in doses greater than 0.57 kg causes significant degradation of thiamine. Excessive oxygen deprivation can not prevent thiamine depletion during irradiation. Under anaerobic conditions, no change in the amount of riboflavin was observed in irradiated pork. Radiated pork retains more thiamine than canned heat-sterilized meats. Degradation of thiamine in irradiated meat during freezing is significantly less than when irradiated material is under environmental conditions. When wheat is given 60 ounces of cobalt, it does not decrease after 24 months of thiamine storage. In irradiated fruits, the shelf life of vitamin C was in the range between 72-100% and beta-carotene and vitamin K were stable in irradiated vegetables. During storage of irradiated oats, peroxides were degraded during the auto-oxidation produced during auto-oxidation. Vitamin A is also sensitive to radiation. But the main source of this vitamin is dairy products and eggs, which are not processed by radiation. Vacuum packaging and low temperatures protect vitamins A and E during radiation and after storage. Vitamin D is not affected by radiation (Ball, 2006).

Sweets, foods with moderate humidity such as breads, dried fruits, seeds, crackers and cookies are suitable for the irradiation process. However, the use of radiation in high-fat products to maintain safety, nutrients, product acceptability must be careful. The possibility of using gamma rays to improve the microbial and fungal quality of various foods has been studied and is used commercially today .Nutrients, essential amino acids, essential fatty acids, minerals, and most vitamins are usually not significantly affected or lost in foods processed by radiation. In this study, data were obtained on the effect of ionizing radiation on the amount of vitamin E and nutrients in whole sunflower seed cookies . The samples were treated with gamma rays and changes in the amount of vitamin E and physicochemical properties were examined .The selected cobalt radiation was at 3 kg and a colorimetric measurement method was used to determine the amount of vitamin E. The experimental results showed that there was a significant stability in the amount of vitamin E (alpha tocopherol) at this dose of gamma rays (Taipina et al., 2011).

Researchers have studied the effect of ionizing radiation, especially gamma radiation, on water-soluble vitamins in plant products.Usually, most freshly cut vegetables (lettuce, parsley, tomatoes, green onions, carrots, celery, and broccoli) can tolerate 1 kg of radiation without a significant change in the amount of vitamin C (Fan et al., 2006).

In the case of carrots and cucumbers treated with minimal radiation, no significant difference was observed between the amount of vitamin C in the control samples and the samples treated during storage in the refrigerator (Hajareh et al., 2006).

In the case of bell peppers, no reduction in vitamin C was observed during storage in the refrigerator and after gamma irradiation (Ramamurthy et al., 2004).

In the case of fresh fruits, it has been reported that the amount of cantaloupe vitamin C in the process was not affected by radiation. No significant differences were reported between processed and unprocessed products in terms of vitamin C stability during storage (Fan et al., 2006).

In the case of non-ionizing radiation in plant-based products, it has been reported that vitamin D2 in mushroom slices increases significantly when exposed to ultraviolet light, which may be due to the conversion of orgosterol to vitamin D2 (ku). et al., 2008).

When mushroom slices were exposed to this artificial UV light, vitamin C was reduced in the juice of regenerated oranges under ultraviolet treatment. Using a dose of 73.8 mj / cm2, the reduction of this vitamin was about 12% (Tran et al., 2004).

The researchers found that the amount of vitamin C decreased rapidly with increasing UV dose .This is due to air oxidation. On the other hand, light treatments used in the form of short pulses with a total flux between 12 kj / cm2 to 12.8 4. The amount of vitamin C, like freshly harvested untreated fungi, changed during 7 days of refrigeration under atmospheric packaging. They maintain the findings (Oms et al., 2010).

4- Microwave energy

The use of microwave energy in agricultural products includes drying, insect control and grain germination. In the food process, its applications include: conditioning, vacuum drying, freeze drying, dehydration, cooking, enzyme removal, roasting, pasteurization, sterilization and extraction, which is also in progress. The use of this technique is suitable for inactivating enzymes and enzyme depletion, and further research is ongoing to study its effect on nutrients, texture, and color of fruits and vegetables. During the microwave process, food quality is one of the most important concerns of the consumer. In microwave-dried foods, complex chemical reactions and transformations increase .These reactions can lead to the breakdown of vitamins, lipid oxidation, and browning reactions. These mechanisms are affected by factors such as concentration, temperature and water activity. Many studies have reported the loss of vitamins during microwave cooking. Water-soluble vitamins C, B1 and B2 are used as indicators of quality changes in this process. The shelf life of vitamins during the blanching process و ,cooking and reheating food in the microwave is similar to the shelf life of conventional heating methods. The rate of vitamin C degradation increases with increasing water activity. Microwave heat has the potential for higher shelf life of heat-sensitive vitamins compared to some commercial methods due to the shorter heating time. The amount of ascorbic acid in vegetables cooked by microwave is higher than usual methods. Cooking pork and chicken in the microwave oven has resulted in longer shelf life of vitamins B2, B6 and B12 than conventional electric ovens. Vitamin B1 in normal roasting and in microwave samples was in the range of 48-67% and 86-94%, respectively, and the shelf life of vitamin B6 was in the range of 60-87% and 48-22% (Hill et al., 1994).

The combination of osmotic pretreatment (usually in sucrose solution) and vacuum microwave in strawberry and apple dewatering has been investigated . Osmically pre-treated specimens had a volume increase of about 20 to 60% relative to fresh fruit volume compared to microwave-vacuum-dried specimens only . Electron microscopy images showed that the cell structure was better preserved when osmotic pretreatment was used .Gel formation between pectin, sucrose and in some cases calcium ions is probably the main reason for this. Vitamin C shelf life of about 60% has been used with this microwave method (Erle and Schubert, 2001).

5- Ultrasound waves

Ultrasound is a high-frequency sound wave that the human ear cannot hear or understand (16 kHz). Ultrasound is a technique for describing the physical properties of many biological and non-biological materials and has many applications in pharmacy, medicine, and other industries and sciences. In chemical processes, ultrasound is used to determine the concentration of solutes in aqueous solutions and to determine the flow rate of liquids in tubes. Therefore, it is not surprising that it can be used to determine the properties of food and in the food industry. The possibility of using ultrasound in the food industry has been studied for about half a century. Two different types of ultrasound are used in the food industry .High intensity and low intensity. Low-intensity ultrasound is used to provide information about the physical properties of materials. The power levels used are low (less than one watt per square centimeter) and the frequencies are low (1-100 kHz) .In this case, there is no change in the physical properties of the food . High-intensity ultrasound is used to change the physical properties of food, in which case high power levels (more than one watt per square meter) and low frequencies (less than 0.1 kHz) are used. The effect of ultrasound on the amount of vitamin C in juices has also been investigated. The amount of this vitamin in guava water was higher than the amount in an untreated sample, which may be due to dissolved oxygen due to cavitation. By removing oxygen, the rate of decomposition and reduction of ascorbic acid is reduced (Cheng et al., 2007).

In orange, strawberry and tomato juice, decomposition of vitamin C has been observed under the influence of ultrasound, and the amount of decomposition also depends on the treatment time and wave amplitude. Decomposition of ascorbic acid during ultrasound may be due to the formation of free radicals and the production of oxidative products on the surface of the bubbles. In this case, increasing the storage life of Mani based on the shelf life of ascorbic acid has shown that ultrasonic orange juice is due to the higher temperature of the process at 98 ° C for 21 seconds compared to samples (Tiwari et al. , 2009).

6-Osmotic drying

The term osmosis refers to a system with at least two solutions of different solvent activity separated by a semipermeable membrane. For example, a barrier that allows the solvent to pass but does not allow the solute to pass, resulting in a solvent flow from a high-activity region to a low-activity region. In the case of fruits and vegetables, water is solvent. Osmotic active ingredients usually include sugars, alcohols and salts. Soluble starch, although low in achievable molar fraction, is an effective osmotic agent. In plant materials, cell membranes form a semi-permeable barrier .In fact, some solutes have the ability to penetrate tissue.

Plant matter may lose certain parts of its compounds such as vitamins and minerals (Erle and Schubert, 2001).

Osmotic drying is an incomplete dehydration process .Often referred to as a treatment to improve product quality in the drying process, osmotic treatment involves soaking food in a concentrated or hypertonic solution (sugar or salt) for a specified period of time under controlled temperature conditions. This method has two major advantages, when used in combination or in comparison with other methods, the quality of products dehydrated by osmotic method is better and shrinkage is much less compared to dried products by conventional methods . Second, this energy technique helps preserve more vitamins than other dryers . The first advantage has been extensively studied, while there has not been much discussion and energy about reducing energy and thus reducing drying costs (Bekele et al., 2010).

In a study, the effect of rapid osmotic dehydration and slow osmotic dehydration on the physical and chemical properties and sensory properties of dried cantaloupes by osmotic method was investigated. It was found that there was less vitamin C in the samples produced by the slow method than by the fast method. In fact, it was found that the loss of nutrients such as vitamin C and phenolic compounds is higher when more time is used in dehydration.

It was also observed that the amount of vitamin C after this type of drying process was lower in all treated samples than fresh cantaloupe. This can be attributed to two reasons: leaching (washing with water) and due to the high degree of solubility of vitamin C in water and its chemical decomposition (Ratanawi et al., 2013).

Apple juice in sucrose and corn syrup is affected by temperature (30-30 ° C), sugar syrup concentration (40-40% by weight) and immersion time (240-90 minutes). In this experiment, the amount of ascorbic acid as a qualitative parameter was investigated and used to find the optimal conditions (Azoble et al., 2003).

7- Cooling under vacuum

When a part of a liquid evaporates, it needs to absorb heat to maintain the high energy level of the molecules. This amount of heat is called latent heat of vaporization, which is provided to the product from the environment, and as a result, the material will cool down. The temperature at which a liquid begins to evaporate is called the liquid saturation temperature, which depends on the surrounding vapor pressure. Reducing the pressure also causes water to evaporate at a lower temperature. Each product has some free water, and if placed in a closed chamber, the pressure is reduced by a vacuum pump . The latent heat required for evaporation is obtained through the perceptible heat of the product itself and as a result the temperature of the product is reduced .The cooling effect continues as the pressure applied by the pump decreases .This process is called vacuum cooling. The final temperature of the product can be controlled by adjusting the vapor pressure inside the chamber, which is usually not less than 6.5 mbar for food products as agglomeration may occur and result in damage .Vacuum cooling is a rapid evaporative cooling technique that is usually obtained by evaporating part of the product moisture under vacuum conditions. This technique has advantages that include shorter process time, increased product durability, improved product quality and safety .As a result, the popularity of this method has increased among food manufacturers and food science researchers. The most important feature of vacuum cooling is that the product cools at a very high speed, which makes it superior to conventional cooling methods. This method is usually used to remove heat from post-harvest leafy vegetables, which increases the shelf life of the product. Since most food products contain a significant amount of water, vacuum refrigeration can be a good refrigeration treatment in the food industry and, unlike other refrigeration methods, it can be a practical and special method for products with high pores. This method is recommended for products that do not change their quality even after losing some water. Therefore, it can be a good way to cool products such as cabbage, mushrooms, etc., if this method is not suitable for cooling tomatoes, apples and oranges (Zheng and Sun, 2005).

8-Nanotechnology

Nanotechnology is the use of particles and materials with dimensions below 100 nanometers that have many applications in the food, medicine, cosmetics and health industries and have recently received much attention. One of the fields and applications of nanotechnology is the production of carriers less than 1 micron in size to enrich nutrients and transfer active compounds such as vitamins and carotenoids to target components (Rieox and Fuse, 2006).

Today, new techniques such as encapsulation and nanotechnology are used to transfer vitamins to food to increase stability against temperature, humidity, oxidation, light, as well as to reduce negative reactions with other compounds. Vitamins and minerals are added to a dry nutrient mixture to enrich a variety of foods, including breakfast cereals, dairy products, and baby food. Both water-soluble and fat-soluble vitamins can be encapsulated with different types of coatings (Gibbs et al. 1999).

Encapsulated vitamins are especially used as a supplement or fortifier in processed products in certain foods .In beverages, for example, encapsulation can mask the taste of minerals and vitamins and provide a tasty product for the consumer (Britto et al., 2012).

Much research has been done on vitamins in four lipid nanocarriers (including nanomulsions, liposomes, and solid lipid nanoparticles) as well as carbohydrate nanocarriers. Nanoemulsions with the ability to improve the solubility of compounds and the potential to increase gastrointestinal absorption are a good option for transporting water-soluble food components such as water-insoluble vitamins .Studies have shown that the bioavailability of encapsulated vitamin E nanoemulsions is ten times greater than the bioavailability of the same vitamin stored in commercial gelatin capsules .Compared to other encapsulation technologies, liposomes can usually provide higher chemical stability and protect sensitive compounds such as ascorbic acid (Fathi et al., 2012).

To prepare solid lipid nanoparticles, the active agents (in this case, retinol, retinoic acid and retinol ester such as retinyl palmitate) were first dissolved in a lipid and then the nanoparticles were prepared by one of three methods of hot and cold homogenization and microemulsion technique. Kurdish (loveda and Singh, 2008).

In one study, nanoparticles produced 100 nm of vitamin E based on modified starch and showed that it was stable in a beverage and did not change the appearance of the beverage (Chen and Wagner, 2004).

Vitamin D2 has been used as a model for hydrophobic medicinal food compounds. These casein micelles were about 146 to 152 nm in diameter (Semo et al., 2007).

Conclusion:

Vitamins are organic substances that play important metabolic roles in the body .For example, many of them act as coenzymes in important reactions in the body. Vitamins are available to the body through food, and any healthy person can get enough of the vitamins they need from a variety of foods. Therefore, the study of the shelf life of vitamins to determine the effects of dietary processes on the value of nutrients is of great importance in food technology and for consumers. There are limitations to studying the stability of vitamins.

In order to study the stability of vitamins, many studies use chemical systems to simplify the research on the stability of vitamins.

The results of these studies must be interpreted with great precision .These studies provide important information about the chemical effects on the shelf life of vitamins, but in many cases the value of these studies is limited to predicting the behavior of vitamins in complex food systems. There is a major limitation to trying to evaluate the stability of vitamins between different forms of each vitamin.

Multiple forms of each vitamin can exhibit different reactivity and stability.

Various processes are carried out from the farm to the time of consumption of the product on animal and plant raw materials with the aim of converting them into ready-to-use products in order to stabilize the product. During various processes, food vitamins are inevitably altered and lost. Numerous factors such as temperature, air or oxygen, light, amount of moisture, water activity, pH, enzymes and the presence of trace elements such as iron and copper are involved in the breakdown of vitamins during the process.

The development of new foods naturally helps to keep vitamins as long as possible, to protect added vitamins, and to minimize unwanted changes in products. Loss of some special vitamins during the food process is inevitable .However, the relative relationship between the reduction of a particular vitamin relative to a particular product must be examined.

Another point to note is that the natural difference in the amount of vitamins in food raw materials that may affect the amount of vitamins in the final product may be greater than the effect of the process alone. The use of physical or chemical protection methods continues, and technological advances are being made rapidly to improve the efficiency of these processes. But such processes can also change the nature of the taste of food and destroy vitamins. Thus, new technologies are emerging that help advance safety, fresh-tasting foods, and preservation of nutrients without the use of heat or chemical preservatives.

These non-thermal processes for food protection have become the focus of many food manufacturers today. New food processing methods such as high pressure process, pulsed electric fields, vacuum cooling, osmotic drying and others have been used to maintain food quality in recent years. The use of these new processes can help in the better shelf life of vitamins in food products.

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