Food Science and Quality Management
ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online)
Vol.39, 2015

Agro-Industrial use of Cactus, a Review

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Abstract
The cactus pear has become an important fruit in many semi-arid lands of the world. The fruit and the young cladodes (nopalitos) have commonly been consumed fresh, but the last decade's research studies on cactus pear processing have produced another alternative which prevents damage to the fruit and in spite of technological characteristics that make processing a challenge (high soluble solids content, low acidity and high pH), adds value to this fruit. The cladodes of the plant are a good source of fiber, an important element for the human diet and of considerable potential for medical use. The result of several of these research studies involving the production of juices, marmalades, liquid sweeteners, dehydrated foods and other products have discussed.
Keywords: Canned Food, Medicines, Industrial Additives, Dehydration Product, Nutraceuticals, Food and Food Derivatives

1. Introduction

Cactus pear or prickly pear as widely distributed in Mexico and in all American hemispheres and grows in many other parts of the world, such as Africa, Australia and the Mediterranean basin. The fruit is fleshy, berry, varying in shape, size, and colour and has a consistent number of hard seeds. The fairly high content and low acidity of the fruit make it very sweet and delicious.

The cactus pear was largely ignored by the scientific world until the beginning of 1980, when there was a multiplication of research and symposia, resulting in a large number of publications, including books and book chapters. Recent data has, in fact, revealed the high content of some chemical constituent, which can give benefit to this fruit on a nutritional constituents and technological functionality basis. High levels of beta lains, fourine, calcium, magnesium, and antioxidants are note worthy [1].

The cactus pear fruit (Opuntia Fiicus Indica) is associated with the semi arid zones of the world; it is one of the few crops that can be cultivated in areas, which offers very little growth possibility for common fruit and vegetables. Commonly eaten fresh, it is know in some areas of the world as the "bridge of life" because, during periods of little rain, it is one of the only crops that can be used as both human food and cattle feed. Recently, several authors have published research about the part harvest of the fruit, as well as its 'nopalitos'. [2]

Consequently, as knowledge of its nutritive value grows, interest in expanding its possibilities is also raised, lending it even greater value through its transformation in to attractive products of longer shelf life. Interesting studies on the cactus pear have been and continue to be made in an attempt to better use this species, which for centuries has been considered an attractive and rich food. [3].

2. Objectives

General objective

- To review agro-industrial use of cactus

Specific Objective

- To review on use of cactus as food and food derivatives, Common food, Soft drink and alcohol, Other food additives, use cactus as medicine and as additives in industries .

3. Literature Review

3.1. Use Cactus as Food and Food Derivatives

One of the oldest ways to preserve vegetable, which are highly perishable, is through different processing systems. Several products are obtained from the fruit; some of them are commonly known, and other has been recently developed or is in a research stage.

3.2. Juice, Pulp and Puree Technologies

The two most common domestic uses of cactus pear are juices and pulps. One of the first research studies on prickly pear juices was done on prickly pear. Cordona studied the Opuntia Fiicus Indica juice, and found several difficulties in its preservation. This author used citric acid to reduce the pH value to 4.3, sodium benzoate and other maltreatment for 5 min at 90^0C; the juice was vacuum canned in enameled tin. In spite of reducing the pH value to 4.0 with lemon juice and carrying out a mild thermal treatment (20 min at 80^0C), the acetic fermentation continued and the juice could not be preserved [4]. Another possibility related to cactus pear juice was

concentrated juice production. The lower of the concentrate relative to the natural juices is a clear protection against the growth of microorganisms and can extend the shelf life of the juice. The study showed that concentrated juices could be obtained with 63-73 Borax; the juice was prepared in Laval centrifuge vacuum evaporator, at approximately 40^0C; the stability of the juice against micro-organism growth was good, but the sensorial analyses found the acceptability was only 5.0 (1-9 points scale)[4]. Their unsatisfactory ranking was due to damage to the colour and the herbaceous aroma that appeared after the concentration process. Another alternative would be the use of only citric acid to improve the acidity of the blends [4]. A concentrated pure (37%) from the cactus pear CV. 'Gialla' and compared the product were similar to those of the natural pulp; the acidity was modified with citric acid to pH 4.0; they concluded that the concentrated pure could be a good in gradient for the candy industry as a semi-processed product [4].

Other researchers have attempted to obtain clarified juices. It is known that juices without pulp can be concentrated to a high degree of solids content, with advantages in terms of both their conservation and the reduction of transport and storage space. The use of pectinolytic enzymes have been tested for this purpose with a treatment at 40 ^{0}C for 48 hour, and with the addition of citric acid. The juice has packaged in cons receives. Both treatments show colour changes due to pasteurization, which is corrected by artificial colorants. Using a Novo prepared with a mix of pectolitic, enzymes and a high activity of arabanase have clarified cactus pear juice with success [4].

3.2.1. Liquid Sweetener Preparation

The transformation of the juice in to a liquid sweetener, using pectinolitic enzyme with a high arabanase activity, has been studied recently. A developed process to obtain a natural liquid sweetener from cactus pear juice; the product had 60 ^{0}Brix (56% of glucose, 44% of fructose), a density of 1.2900 $gm1^{-1}$, 0.83, similar to that of honey or marmalades; a light golden-yellow colour and a viscosity of 27.1 cps. The sweetness is 67 compared with sucrose. These characteristics are similar to those of other liquid sweeteners currently marketed [1, 4].

3.2.2. Gel, Jam and Technologies

The use of cactus pear pulp to prepare gels, such as the apple or quince gels common to many countries markets opens on other possibility for this fruit. Adding a gelling agent and sugar to the pulp (35-40%) two pH levels were tested. At pH 3.5, the Fruit Prevent from microbiological growth due to the transformation of chlorophyll in to phenophytin and 6.1 (the original of the cactus pear pulp); a marked colour change was observe. However, the product maintained its chemical, physical and sensory characteristics for 14 more days at refrigeration temperatures (4-6^{0}C). [3, 4].

Several studies have been carried out in different countries on other cactus pear products. Manufactured prickly pear jam, with and without blanching the fruit; sensory evaluation tests resulted in non-significant differences. The proportion was a prickly pear pulp: sugar ratio of 60:40; 1.25% pectin; citric acid or citric and tartaric 1:1. Flavors such as cloves, grape fruit extract, orange extract and almond flavor gave better results than other flavors tasted. In addition, the jam contained 20% date pulp. Made a jam with cladodes (cactus stems or pads), instead of the fruit, adding juice, orange peel, and sugar to the ratio 1:1. 5:0. 8:0.08. The jam had no microbial growth after 40 days of storage. This product showed no difference from other jam in the Mexican market in aroma, colour, taste, texture and appearance [5].

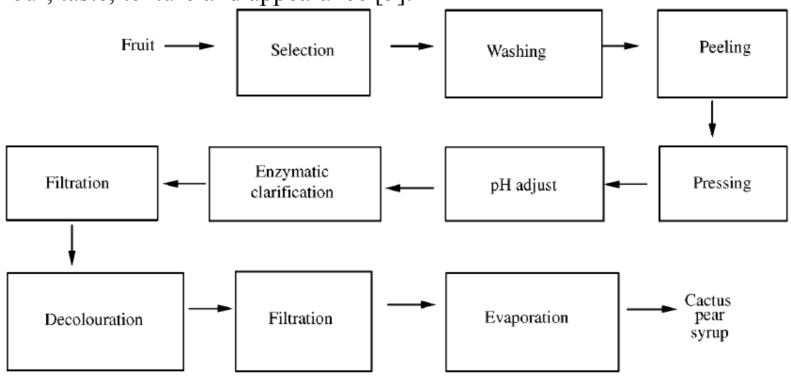

Figure 1. *Processing scheme for cactus pear syrup*

Made a jam with cladodes, sugar and citric acid in the proportion 1:0.6:0.01, obtaining a product with good sensory quality and microbiological stability. Made a marmalade from cladodes using previous treatment plus a 2% solution of Ca $(OH)_2$ to lower the mucilage content, which damages texture and acceptability. The final formulation used lemon juice and lemon peel. The first lowered the pH and the second contributed pectin to the gelling of the product [6].

The author tested several proportions of sugar syrups (sucrose and glucose) and tested sweet and bitter chocolate coatings; the products presented very good characteristics and sensory quality with a_w of 0.53-0.63. The energy value differed (306.3-340.4 kcal $100g^1$), depending on the product were converted with chocolate

(7.6) compared to the non-chocolate converted products (6.3) [7]

3.2.3. Canned and Frozen Products

Cactus pears been canned experimentally, both in glass and steel tin. In the latter case, the addition of 45 ^{0}Brix syrup was tested with thermal treatment for 15 min at 100 ^{0}C. Some of the result was contradictory and changes in colour and fruit texture could possibly be lesser. Studied the canning of different cultivars of Opuntia Focus Indicia from south Africa; she studied the difference cultivars firmness while hand-peeled fruit was canned in acidified sucrose syrup (20 ^{0}Brix) at 100^{0}C for 15 min. With increasing processing time, fruit firmness decreased, however, it increased with fruit resulted in loss of texture, colour and flavor [1].

As another alternative to preserving the fruit, manufactured frozen fruit, using slices of 0.625 mm thickness and quarters of peeled and unpeeled fruit. The freezing process was done in a fluid bed tunnel at-40^{0}C, and samples were stored at -20^{0}C. The result achieved was not satisfactory due to the high drip, mainly from the slices during defrosting. This fact, together with a significant loss of texture, caused the low acceptance of all three alternatives tested. Possibly, the use of protective substance such as syrup or solid sugar could improve the results of this preservation process [5, 7].

3.2.4. Dehydration Product

Dehydration is on age-old process of preserving food. Mentioned dried prickly pear as another edible form of the product. In a slightly modified preservation procedure, tested prickly pear sheets using a Taifi cultivar. The optimum formulation was obtained by adding 10% sucrose, 1.1% citric acid, 0.15% Sodiummetabisuphite and 0.5% olive oil to the fruit pulp. Sodiummetabisulphite improved the colour, and citric acid produced an acid taste similar to that of traditional apricot sheets. A small tasting panel found the sheets extremely acceptable, rating them with a score of 8 out of 9 [3, 8, 9].

The authors tested different proportions of pulps and found the best blend to be 75:25, cactus penal: quince pulp. The blend was dehydrated in a forced air tunnel in thin layers until moisture content was approximately 15-16%. The product had a pleasant texture, and the components of the fruit gave it a moistness that permitted immediate consumption. This kind of product is well-liked by children and can be considered energy food, with caloric values of about 319-327 cal 100 g^{-1} [8].

3.2.5. Composition and Main Nutraceuticals

Nutritional Components, such as lipids, protein, minerals, and fiber, do not differ significantly from other tropical fruits when the whole peeled fruit is ingested, the large quantity of insoluble fiber in the seeds provides the major source of fiber in cactus fruits. The nutritional importance of cactus pear fruit appear clear, therefore important compositional factor is the presence of pigments, which give particular attractiveness to fruit and products. Chlorophylls and battalions are present in green and purple fruit, respectively. The particular flavor of cactus pear is due to volatile components. Sixty-one aromas volatile have been found in a white flesh cultivar of Opuntia Ficus-Indica (L.) Mill. Most of them is alcohols [5, 9, and 10]. Another varieties (yellow fruits) some unsaturated aldehydes, such as 2,6 nonadieal and 2- nonenal, were predominant showed that the most important aroma contributors of yellow, red, and white Italian cultivars of O.Ficus-indica were (E.Z)-2,6 nonadien -1-01 and 2-methyl-acid methyl ester, which accounted for almost 97% of the total aroma value, the former giving the typical odour of the fruit, the latter contributing to the fresh fruit odour[5,10].

3.2.6. Characteristics of the Pear Fruit

Several research studies have been carried out on the chemical composition of cactus pear fruit, also known as prickly pear. As fresh fruit, the cactus pear has a similar composition to other fruit and vegetables but the knowledge of composition is the basis for only successful technological process. The chemical and mineral composition described by different authors shows that cactus pear have a similar nutritional value to other fruit. However, are soluble solids content reaches value greater than 16% a value greater than that present in other fruits, such as prune, apricot, and peach. Such as, it is a very useful component for processing the fruit in to concentrated juices or dehydrated product, or for other technologies that use sucrose content or low a_w to preserve the product. In read to sugar, the fruit pulp is about 53% glucose, and the remaining 47% fructose. This amount of glucose is notable, as this sugar is the sole energetic metabolite for the brain and nerve cells and is present in the prickly pear as free sugar, directly absorbable by the body. Also easily absorbed, fructose enhances flavor, as it is sweeter than either glucose or sucrose. The caloric value of the pulp according to is about 50 kcal 100g^{-1}, comparable to that of other fruits such as pear, apricot and orange. The other components present in cactus pear pulp are protein (0.21-1.6%), fat (0.09-0.7%), fiber (0.02-3.15%) and ash (0.4-1%), all of which are similar to other fruits. The total content of free amino acids value found above average in other fruits. In comparison with other fruits their high content of serine amino butyric acid, glutamine, praline, argentine and histidine, and presence of methionine cactus pear show a high level of ascorbic acid, which can reach levels nears 40 mg 100 g^{-1}, such a concentration of vitamin C is higher than that of apple, pear, grape and banana. Sodium and potassium content in cactus pear pulp shows a good source of potassium (217 mg 100g^{-1}) and a low level of sodium (0.6-1.19 mg 100g^{-1}) which is an advantage for people with renal and blood pressure problems. Calcium and phosphorus represent three quarters of the minerals of the body and are found fundamentally in

bones, which serve as an important reservoir. Prickly pears are rich in calcium and phosphorus, 15.4-32.8 mg $100g^{-1}$ and 12.8 -27.6mg $100g^{-1}$, respectively. [5,11,12].

3.3. Soft Drink and Alcohol from Cactus

Another alternative use of cactus pear is in the cottage industry preparation of alcoholic beverage is obtained through fermentation of the juice and pulp in wooden barrels, a procedure with certain imperfections that, following this study, could be overcome. Other studies made to obtain alcoholic beverages from cactus pears show the use of Saccharomyces Cereviseac Montrachet with SO_2 (10 ml 1^{-1}) and citric acid to decrease the pH to 3.3. Experiments carried out in order to obtain wine varieties used for wine, O. Streptacantha And O.Robusta, both had similar, delicately pleasant, fruit like characteristics. The alcohol, in turn, had fruit like characteristics and a pleasant taste, with an initial and prevailing wine aroma. Among them appears the 'tuna cheese', prepared with cottage industry procedures, based on the boiling of the pulp and juice until a certain viscosity is obtained ('melcocha'). The juice, highly concentrated and beaten, is then placed in rectangular recipients, usually of 1kg, which are sold once the 'cheese' has dried, raisins, nuts and pine nuts be added to enrich its flavor.

Another potential product that can be obtained during fruit processing is seed oil. This oil is edible and has a yield range between 5.8 and 13.6. The oil shows a high grade of non-saturated acids, with a high content of linoleic acid (57.7 to 73.4%). These and other physical and chemical characteristics, including the refractive index, iodine number, and saponification number, make it similar to other edible vegetable oils such as corn or grain seed oil [4].

3.4. Other Food Additives

In other area, the constant search for natural additives as pharmaceutical, cosmetic, and colorants suggests that the research carried out on the purple cactus pear is on the right track. Well know and widely used in the food industry, as powder or concentrated juice is the pigment obtained from the red beet, whose colour is due to the presence of betalain (the same pigment present in the red prickly pear). Research studies on extraction, identification and stability of the pigments of the purple prickly pear, found a yield of 16g of 16 mg of betanin peer 100g of fresh product reported different quantities of betacy anines for several species of Opuntia, where opuntia SP. Pointed out the presence of neobetain in the fruit pulp and found a betanin neobetanin ratio of about 1:2.5 in Opuntia Ficus Indica. Determined 100 mg $100g^{-1}$ of betanin in a concentrated juice of purple cactus pear juice with color parameters of L*=22.8, a*3.8, b*=3.8 and H*=5.1.

Table 1. *Chemical and physical characteristics of the colour extraction of opuntia [12,13]*

Parameter	Average
Soluble solids (0Brix)	61.5
Acidity (% citric acid)	0.81
PH	4.3
Betanin (mg 100g-1)	100
Colour parameters	22.8
L* (lightness)	0.34
A* (red)	3.8
B* (yellow)	0.34
C* (chroma)	3.82
H* (hue)	5.11

3.5. Use Cactus as Medicine

There is extensive variety of disease that popular medicine (mainly Mexican) claims can be fought and cared with the **'**nopal' or cactus pear**,** or parts of the plants or their flowers. Few of these applications have any degree of scientific basis, although their effect can be cited in cases of diabetes mellitus, hyperlipidemy (excess of lipids in the blood), and obesity. To this effect, studied the hypoglycemic effect of Opuntia Fiicus Indica stems, found that glycemia decreased in all patients tested following ingestion of Opuntia Fiicus Indica, and reached statistically significant levels after 120 and 180 min. In another study, confirmed this hypoglycemic action. Presented a review of evidence on the reduction effect of opuntia in the serum glucose, and with access to eight different reports they concluded that this meta-analysis suggested opuntia had a strong glucose reduction effect. They further indicated that these findings, however exciting were preliminary at best. Evaluated the hypoglycemic activity of a purified extract from prickly pear cactus (Opuntia Sp.) on STZ-induced diabetic rats. They concluded that, although the mechanism of action was unknown, the magnitude of the glucose control by the small amount of opuntia extract required (1mg kg^{-1} body weight per day) precluded a predominant role for dietary fiber for hypoglycemic activity. The experiment involved giving a dosage of 30 capsules, each containing 335 of dried nopal cladodes, to diabetic Subject, with serum glucose levels measured intermittently every 60 min for 3 hour, a control test was also performed with 30 placebo capsules. It was conclude that nopal capsules did

not tolerate test. In diabetic patients' serum glucose, cholesterol and triglycerides levels did not change with opuntia, but they increased with placebo. In healthy individuals glycemia did not change with nopal, while cholesterol and triacylgly cerides decreased. The effect of the prickly peak over the metabolism of the low-density lipoproteins has been studied, suggesting, through its results, that the extract of prickly pear would action a similar way to that for other compounds used to decrease cholesterol levels. [13.14].

4. Conclusions and Recommendation

The increasing interest in cactus- pear cultivation in the decades has keenly stimulated the work of scientists to overcome the lack of knowledge about all aspects. If we consider that a number of uses and application of cactus pear fruit are possible, we realize the importance of this crop to human food, in all its aspects. However, much more knowledge is needed to have a realistic possibility of extensive development of this crop. We have to solve problems such as breeding for higher fruit pulp content and lower number and size of seeds, improving postharvest technologies (harvest and processing), selecting cultivars for higher nutritional and functional properties (colorants and fibres), and optimizing current processing technologies, as well as exploring new ones. The increasing demand for natural rather than synthetic colorants for drink and dairy products could benefit cactus pear, provided further studied on increased yield, extractability, and stability are carried out. The promising thing is that this very attractive crop will substantially reward human exploitation in all the depicted ways and in all parts of the world.

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