A Review of Green Pea's Food Potential and Processing for Quality Sustainability

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Abstract- ***This paper focused on postharvest handling of green pea (Pisum sativum L.). The Green pea is an annual leguminous crop which has a short life span of 3 to 4 days; it is grown and consumed by humans and contains low calories but rich in fiber, micro and macro nutrients. In-depth review of the potentiality of green pea as food, its health benefits, the various pretreatments and processing methods as well as storage methods was done. The short-comings in the existing methods used in the pretreatment and prolongation of the shelf-life of green pea were identified. The knowledge gaps in the reviewed literature were identified as areas for research and development activities that are capable of creating innovative opportunities for jobs in the food industries and in small and medium scale businesses.***

Indexed Terms- ***Green Pea, Pretreatment, Processing, Prolongation, Food***

I. INTRODUCTION

Green Pea *(Pisum sativum L.)* is a legume grown and consumed throughout the world and it is widely used in several human diets (McCrory *et al*., 2010). Green pea is mainly consumed as a green vegetable with its immature pods and seeds. It can be said to be one of the important leguminous crops grown in 84 different countries and constitutes the largest percentage (36%) of total pulse production in the world (Dahl *et al*., 2012). Global pea production has shown a rise for the last 30 years. In 2008, field pea was cultivated in over 10 million hectares worldwide with a total world production of 12.13 million tons (Schatz and Endres, 2009). The crop is an annual vegetable grown largely in countries with cool climate, for example, China, India, France, USA, Kenya and Egypt. In Nigeria it is grown in the middle belt states like Plateau, Benue and Nassarawa areas (Lin *et al*., 2005; Pardeshi *et al*., 2009) the fruit is a typical pod which has four to nine seeds and length of about 5 to 9 cm; it has an inflated shape. The green pea is a seasonal crop, and thrives well during cool seasons. The shelf life is not more than 3 to 4 days after harvest (Madhuri and Tayade, 2019; Tanushare and Saxana, 2017).

Legumes and green pea especially play integral role in sustainability of agriculture by its ability to replenish soil nutrient and maintain soil properties. Peas are highly susceptible to changes after harvest, during processing and storage; they hence require proper handling to maintain their quality (Tanushare and Saxana, 2017; Rohit *et al.*, 2017).

This paper presents a review of potentiality of green pea as food, health benefits of green pea, the various processing and storage methods, and also some identified prospective areas of research and development in relation to postharvest handling of green pea for optimum storability and enhanced quality.

Figure 1: Green pea pod

Figure 2: Green pea seed (source: postharvest lab. Federal polytechnic, Bauchi, Nigeria)

- Green Pea Food Potential and Nutritional Value

Green pea is an important food resource that contributes to the nutritional wellbeing of humans, and it is consumed in various diets (Uebersex and Occen, 2003). It is an excellent source of nutrients and contains appreciable proportion of digestible protein (23-25%), carbohydrates (50%), minerals and vitamins (Madhuri and Tayade, 2019; Tanushare and Saxana, 2017). Green pea is also a source of micronutrients and phytochemicals. Their nutritional properties have been linked in the reduction of various cancers, LDL cholesterol, type -2 diabetics and heart diseases (Bassett *et al.*, 2010; Roy *et al*., 2010; Cryne *et al*., 2012; Ldjal and chibane, 2015).

Green pea is considered a potential source of antioxidants because of its high content of carotenoids and polyphenols (Oruna-concha *et al.*, 1998; Chauresi *et al*., 2012). It is low in fat, high in fiber and contains no cholesterol. Peas are excellent source of vitamin C, vitamin B1 (Thaimine), vitamin B6, B3 (Naicin), B2 (riboflavin), Pro-vitamin A carotenoids (Tanushare and Saxana, 2017). Chuku *et al.* (2019) investigated the mycoflora and nutritional constituents of *P. Sativum* for healthy and spoilt samples and reported the presence of moisture, ash, fibre, lipids protein and carbohydrate in both samples. Highest values were reported for healthy samples; and mineral composition analysis showed the presence of calcium, potassium, sodium, iron and magnesium.

Green pea can be boiled and eaten as a vegetable; dried or prepared as soup and salad. It can also be marketed fresh, canned or frozen for future use (Sharma *et al.*, 2015). The dried ripe pea are consumed whole or made into flour. They can be used in purees and processed products. Dried peas are eaten as dhal, roasted, parched or boiled in some parts of the world (Messiaen *et al.*, 2004). Garg (2015) found green pea powder to contain proximate and mineral properties and that the powder can be used for making Jaggery biscuits.

Pea starch has been used to prepare noodles by high temperature extrusion process and this showed superior quality than noodles prepared from lentil starch (Wang *et al.*, 2014). Agnes and Joseph (1986) produced Akla from yellow pea flour and reported some properties of the batter indicating that the presence of hull in the batter increased the specific gravity and decreased the batter volume; and that the moisture content of the batter had a linear relationship with oil absorption of the akla. They also reported that low moisture batter produced heavy textured Akla.

- Health Benefits of Green Pea

Foods rich in fiber are important for improvement of healthy gut one of the most effective ways to improve the health of your gut (Hills *et al*., 2019). Fiber is essential for healthy digestion (Akbar and Shreenath, 2023).

Peas are rich in fiber. They contain up to 65% fiber, including 10–15% insoluble fiber and 2–9% soluble fiber (Shanthakumar *et al*., 2022). Soluble fiber promotes healthy blood sugar and blood lipid levels while supporting the growth of beneficial bacteria in the gut (Akbar and Shreenath, 2023). High-fiber diets is reported to protect against gut-related health conditions such as colon cancer, diverticular disease, and constipation. Research shows people who follow higher fiber diets may have up to a 21% reduced risk of colon cancer compared to people with low fiber intake (Hills *et al*., 2019).

Peas have a relatively low glycemic index (GI), which can help manage blood glucose (Gao *et al.*, 2019). The GI index measures how quickly and high blood sugar rises after eating certain foods. The fiber and protein in peas can also help keep you full for longer between meals, reducing snacking, thus, preventing the blood sugar rise. It also helps in preventing macular degeneration because of the high content of vitamin A. One half-cup serving of green

peas contains 47% of the recommended daily amount of vitamin A, (Thirunavukarasu *et al*., 2022).

Hills *et al* 2019 has proven that a fiber-rich diet can lower risk of developing heart disease, and as earlier stated, peas are a better way to increase the amount of fiber in human diet. But it's not only the fiber content that gives them cardiovascular benefits. Peas also contain a good amount of magnesium, potassium, and calcium, which are heart healthy minerals. Potassium lowers blood pressure, calcium from food sources is shown to reduce the possibility of developing heart diseases while magnesium transports calcium and potassium to the heart. Thes three minerals in green pea makes it natures support pack (Ellison and Terker, 2015; Anderson *et al.,* 2016).

- Green Pea Processing

The rate of spoilage and biological degradation of agricultural crops is dependent largely on postharvest handling and storage conditions. Postharvest processes include the integrated functions of cleaning, grading, cooling, blanching, drying, packaging, storing, transportation and marketing. It involves the practical application of engineering principles and knowledge of fruits and vegetables to solve problems (Fasana, 2006).

Cleaning of green pea entails removal of foreign materials such as pods, leaf stock, and other debris that are considered foreign to the required produce. This can be done by mechanical depodder or by handpicking. Grading is the separation of green pea into classes beyond the physical properties. Grading is classified into chemical and biological properties. Blanching is pretreatment with hot water or steam at the right temperature and time to preserve colour, nutrients and deactivate enzyme activity (Krishna *et al*., 2014; Barzegar *et al*., 2015, Prakash *et al*., 2019).

Recently, Cellophane, polyethylene bags, cardboard boxes, polyethylene bags are used as packaging materials to protect legumes from intrinsic and environmental damages. Volumetric fully automatic filling system and vertical type packaging machines are used in packaging legumes. Well packaged legumes can last as long as two years (MEB, 2013).

Fresh vegetables which contain vitamin C starts to degrade immediately they are harvested, because they are perishable in nature and are seasonal, for example, green pea and lettuce (Daniela *et al.,* 2016; Fasana, 2006). To minimize loss of valuable nutrients and general postharvest losses, various methods have been used to process green pea which include: chilling for short term preservation of green pea, freezing, boiling, drying, and blanching (Howard *et al.*, 1999).

Freezing was considered the simplest and natural way to preserve vegetables for retention of quality during long period storage (Cano, 1996). This is because they exhibit better sensory qualities such as flavor with minimal distortion of heat sensitive nutrients (Maity *et al.,* 2011). The problems with this type of processing and preservation method include epileptic power supply (as in developing countries) and deteriorative enzymatic actions on texture, colour, and flavor even at zero temperature (Williams *et al*., 1986). Frozen green pea can deteriorate as a result of inefficient blanching, freezing and improper postharvest handling and storage (Tanushare and Saxana, 2017). Daniela *et al. (*2016) reported the losses of nutrients during prolonged storage at chilling temperature of 4 – 6 ^{0}C and that vitamin C decreased after seven days of storage.

Drying of food preserves it nutrients and protects it by reducing moisture that micro-organisms require to thrive. Microbes need minimum amount of moisture to grow (Pandey *et al.,* 2016). Green pea can be preserved by drying. Dried peas are becoming popular because they have longer life span and palatable; and ease of handling, packaging and storage is also enhanced by reduced weight and volume of the dried pea (Chauhana and Srivastava, 2009; Messiaen *et al.,* 2004; Shukla *et al.,* 2014).

Jayaraman and Gupta (1992) used thin layer drying method to dry blanched and sulphited green pea to retain color, taste and texture of the final product. Drying time was 3 hours to achieve 7 - 8 % moisture content. They also reported that spouted bed drying is more efficient than open sun drying, with a drying rate of 3.5 times the drying rate for open sun drying. Microwave vacuum drying has been used to evaluate the quality of dried peas. It was found to increase the drying rate to 0.59 l/min compared to the hot air

convective drying at 0.20 l/min with minimal deformation in the pea structure (Tanushare and Saxana, 2017). Radiation processing have also been used to process pea sprout and was found not to affect the quality parameters such as vitamin C content, total carotenoids, color and texture over a storage period of 12 days at 4 and 8^0C. The sweetness and softness of pea increased with increase in dose of irradiation after the storage period (Hajare *et al.,* 2007).

- Pretreatment of Green Pea

Blanching

Blanching is a thermal process which exposes plant tissue to heat. Steam or hot water is used at a given time and specified temperature to inactivate enzymes and to reduce microbial activities. The blanched material is rapidly cooled down to minimize the loss of heat–labile components (Luh and Lorenzo, 1988). Blanching, drying, acid and sodium treatment are postharvest treatment carried out on agricultural produce to enhance its taste and prolong the shelf life. Drying of food preserves its nutrient and protects it by reducing moisture that microorganism require to thrive. Microbes need minimum amount of moisture to grow. Pandey *et al*. (2016) studied the effect of blanching on drying of green pea at drying temperature range of 60ºC to 80ºC with pea diameter range of 5 mm to 10 mm and reported that blanching and drying led to a reduction of moisture content at different temperatures of drying. Also, Taiwo and Adeyemi (2009), studied the influence of blanching on the drying of banana slices and reported that the effect of blanching at 60ºC for 10 min followed by drying at 50 – 80ºC had significant impact on shrinkage and moisture loss.

Severini *et al*. (2015), investigated the effect of different blanching systems and dehydration on dehydration speed, color characteristics and showed that blanching was important. Similarly, Madhuri and Tayade (2019) investigated the effect of drying, blanching and rehydration behavior on the quality of green peas. They used a cabinet tray dryer at temperatures of 50, 60 and 70ºC and blanched at 85ºC for 1 min and reported that drying rate was higher at 70ºC and higher moisture content for blanched green pea. Priyadershini *et al.* (2013) also worked on blanching of green pea treated with citric acid at 85ºC and dried in a microwave at 3 different temperatures and found that blanched samples had shorter drying times than the pretreated and control samples. It was also discovered that high microwave power resulted in a shorter drying time. The blanching temperature was not varied which could result in better sensory qualities of dried green pea.

Doymoz and Kucuk (2017), reported that pretreated green pea subjected to blanching at 80ºC dried faster than the control sample and that pretreated with ethyl oleete (Kingsley *et al.,* 2007; Srimagal *et al*., 2017). Also drying rate increased with increasing temperature. In the same vein, Pandey *et al*. (2016) dried blanched and unblanched green pea using fluidized bed dryer at 60 to 80ºC and blanching temperature of 70 to 100ºC and reported that as the diameter of green pea increased, the drying time also increased and that the moisture content reduced as drying time increased. In a similar manner, Prakash *et al*. (2019), carried out a comparative study on blanched and unblanched green peas. Blanching was done at 70 – 100ºC with citric acid (0.1 – 0.2 mg/ml) at different diameter sizes and subjected to drying. The researchers reported that moisture content reduced faster with blanching at a lesser time as compared to without blanching.

Drying

Drying is a unit operation and a pretreatment method for grains and crops generally for removal of moisture through heat and mass transfer that is performed with the intention of preservation (Keneni *et al*., 2019). Drying of food preserves its nutrient and protects it by reducing moisture that microorganism require to thrive. Microbes need minimum amount of moisture to grow (Pandey *et al.,* 2016). When considering drying processes, the most cost-effective method for industrial and small-scale purposes is considered (Nascimento *et al*., 2019). However, if the correct conditions are not set, processes can have a low benefit and cause loss of product quality. Drying duration depends on the nature of the product, the drying method or technique applied, and the drying conditions. The most commonly adopted drying practices for green peas and other vegetables are solar drying, sun drying, convective hot air drying, fluidized bed drying, microwave drying (Pardeshi *et al.*,2009, Priyadarshini *et al.,* 2013, Deshmukh *et al*., 2015, Pandey *et al.,* 2016).

Researchers have investigated the effect of drying and drying kinetics on different produce, Bharti *et al*., (2019), worked on the extraction and drying of starch from mango kernels and reported that it has influence on the final properties such as water holding capacity, solubility and swelling properties. The influence of sun drying and oven drying on the functional properties, phenolic content and antioxidant activity of grain flour was studied by Sogi *et al*., (2013) and they reported that freeze drying was most effective for preserving antioxidants. Drying can also affect the physical and chemical properties of agricultural products (Sarpon *et al*., 2018, Dantas *et al*., 2018).

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Effects of drying on foods

Microbes require some quantity of moisture to thrive. Each microorganism requires an optimum temperature for the growth; however, increasing temperature above certain value stops the growth. Drying is a process that transfers heat and mass, which can cause changes in product quality (Priyadarshini *et al.,* 2013; Severini *et al*., 2015; Shete *et al*., 2015; Pandey *et al*., 2016; Madhuri and Tayade, 2019). The examples of the products that are dried include cereals, oilseeds, legumes, and some processed foods. In addition to preservation, drying lowers the cost of packaging, storage and transportation by reducing both the weight and volume of the final product (Doymaz and Kocayigit, 2011). Water content for properly dried foods varies from 5 to 25% depending on the food. When drying foods, the key is to remove moisture as quickly as possible at a temperature that does not seriously affect the flavour, texture and colour of the food. Drying technique preserves the original taste of food, flavour and retain colour.

Green Pea Storage

Storage of green pea is necessary since it is a short period crop with life span of 3 -4 days after harvest and a seasonal crop of less than 5 months (Tanushare and Saxana, 2017; Madhuri and Tayade, 2019), so as to have it at off season. Some research has been carried out on the storage of green pea (Shinde *et al*., 2019). Rahul *et al*.(2015), investigated the storage quality of shelled green peas under modified atmosphere packaging at different storage conditions of T_1 (40 ± 1^0C and 92 ±2 % RH) and T_2 (10 ± 1^0C and 90 ±2 % RH) and stored for 8, 16 and 24 days. The study revealed that shelled green peas can be stored in MAP with 3 perforations (0.4 mm diameter) with temperature range of 4 to 10^{o}C and relative humidity of 90 -94% for 24 days with marketable qualities.

The effect of storage conditions on quality and shelf life of stored peas was also investigated by (Rahmawati and Muhammad, 2020), Babatola *et al*., (2008) using a deep freezer (0^{o}C, 95% RH), room refrigerator (12^{o}C 85 % RH) storage incubator (8^{o}C, 80% RH) and ambient storage environment (32^{o}C, 85% RH) and three varieties of peas (green pea *(pisum sativum*), green bean *(phoseolus vulgris*) and runner beans *(phaseolus coccineus)*. They reported that storage conditions in terms of quality preservation were better with deep freezer followed by room refrigerator.

Preetinder *et al. (*2021), used low-dose aqueous ozone treatment and packaging to extend the quality and shelf life of green peas pod under cold storage. They used untreated green pea pods packaged in 3 different packaging films of different thicknesses of 38 µm LDPE, 25 µm PP and 25 µm HDPE stored at 5, 10 and 15^{o}Cand relative humidity of 80 ± 5% for 12 days. The researcher also used sanitization effect using sodium hypochlorite solution and aqueous ozone at modified atmospheric packaging and stored at low temperature of 5^{o}Cand the result showed a slight change in the

biochemical parameters and recorded extended shelf life of 16 days.

Changes that occur in the nutrient content of some green vegetables during storage and thermal processing was studied by Daniella *et al*. (2016). They analyzed fresh , chilled, frozen and boiled broccoli, spinach, green beans and green pea. They reported that there were losses of analyzed nutrients during prolonged storage using refrigeration for 7 days and after thermal processing at time interval of 5 – 20 min, but that total carotenoid and vitamin C were more stable.

Jayaranjan *et al*. (2016) used Glycine Betaine as protection of green peas during blanching at 100^{o}C at 60 s, freeze storage (-20 ^{O}C at 90 days) and they reported that the outcome was most desirable with high level vitamin C and superior green color. The challenge with this method of storage is that the chemical used for preservation could be harmful to human, the cost of maintaining the freezer for 90 days by medium or small-scale farmers is exorbitant.

Shortcomings In the Processing and Storage Methods of Green Pea

Green peas are most often frozen or processed in developed countries like in the US whereas in developing countries they are harvested and used mainly for culinary purposes before they attain certain physiological maturity due to inadequate freezing and processing facilities (Basterrechea and Hicks, 1991; Haiying *et al*., 2007). The main shortcoming with freezing in developing countries is the epileptic power supply which can lead to break down from enzymatic action on texture, color, and flavor. Inefficient freezing and improper handling of green pea can lead to rapid deterioration (Daniella *et al.,* 2016; Maity *et al*., 2011). Daniella *et al*. (2016) also reported losses of nutrients in green pea, green beans and spinach during prolonged storage using refrigeration for 7 days. Freezing is an energy intensive storage method below 0^{o}C and requires high cost infrastructure and uninterrupted power supply to maintain the quality of green pea during storage. Also, freezing can affect the appearance due to freezing injury. The quality of the food is also affected by prolonged freezing (Haiying *et al*., 2007; Rahul *et al*., 2015; Babatola *et al.,* 2008).

Modified atmosphere packaging (MAP) is a new and current method of food preservation for a prolonged shelf life of respiring products. MAP together with cold storage of vegetables is also considered the best way to prolong their shelf life and maintain other sensory qualities (Day, 1996; Sandhya, 2010; Philips, 1996). The shortcomings of MAP storage methods are that it also requires power to sustain the cold storage facilities; and the storage period does not exceed 24 – 30 days, and concentration of CO_2 in MAP films cause deterioration of the product (Rahul *et al*., 2015).

Irradiation is the application of ionizing radiation on food to improve its safety and extends the shelf life. Irradiation was used to process pea sprout as a means of storage and was found to only last for 12 days at temperature range of 4 to 8^{o}C (Hajare *et al*., 2007). The period of storage does not equate the amount of fund expended.

CONCLUSIONS AND FUTURE PROSPECTS

This review has shown that green pea has tremendous potential in the food and pharmaceutical industries considering its nutritive content which include phenolic and oxidative components if proper postharvest treatment is carried out. Also, the review has revealed a good number of processing methods as well as storage methods for shelf-life prolongation of green pea, but clarity on effect of such methods on quality characteristics is lacking. It was also discovered that blanching temperature and time which have significant effect on the quality of the product were not varied which has given rise to the research need for optimization of blanching temperature and time as they affect drying characteristics and functional properties of green pea.

The integration of blanching temperature and time after scientific optimization would go a long way to developing suitable model for green pea pretreatment for enhancement of storage and preservation of this product thereby leading to improvement in rural entrepreneurship. Information on quality, organoleptic and functional attribute of pretreated and stored green pea is lacking, hence giving impetus also for research and development in this area.

Green pea is low in fat and calorie but rich in several nutrients and fiber, therefore acceptability of pretreated green pea for supplementing nutrients in the diets of the people in the urban areas is also an area of attention for researchers. Green pea is a seasonal crop; to have it year-round integrated / backyard farming system of this crop is encouraged. This will in turn serve as source of steady revenue to rural farmers and supply to food and pharmaceutical industries.

ACKNOWLEDGEMENT

The authors acknowledge the support of Tetfund Center of Excellence for Integrated Farming System, Federal Polytechnic, Bauchi, Nigeria for funding this publication.

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