

BIOLOGICAL AND MECHANICAL PROPERTIES OF SILICON DIOXIDE AND ZIRCONIA-BASED EPOXY POLYMER COMPOSITE

NITESH KUMAR DIXIT, DEEPAK AGRAWAL

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Abstract

Processing tomatoes not only helps to reduce the significant post-harvest losses that are seen in tomato crops, but it also ensures that enough quantities of tomatoes are accessible at all times of the year. As a result of the closure of multiple tomato processing enterprises over the last three decades in Ghana, tomato processing has seen a major reduction. This has led to an increase in the nation's dependence on tomato paste that is imported into the country. This study presents a review of the tomato processing industry in Ghana and assesses the potential measures required for the sustainable operation and management of processing plants. Additionally, the study presents the potential measures required for the sustainable operation and management of processing plants. In addition to this, the research conducts an analysis of the prospective steps that are necessary for the operation and management of tomato processing facilities in a sustainable manner. This will help to revitalise the tomato processing industry, which will eventually lead to an increase in the levels of revenue earned by farmers and processors, as well as a corresponding increase in the amount of taxes paid by the government. If concerns regarding logistics, the supply of raw materials, and the requirements for equipment are addressed, it will be easier to maintain the processing plant. are favourable for the biomedical implantation.

Keywords- Epoxy; SiO₂ & zirconia nanocomposites; properties; biomedical implant.

1. INTRODUCTION

The tomato, also known as *Solanum lycopersicon*, is a vegetable that is a member of the Solanaceae family and has more than 300 different species (Knapp, 2002). The tomato is Ghana's most popular and widely eaten vegetable (Schippers, 2000). In Ghana, there has been a constant and consistent growth in demand for both fresh and processed tomato products than there has been for other types of vegetables (Melomey et al., 2019). In 2013, Ghana's domestic tomato production was projected at 340, 218 tonnes, while the country imported 5945 tonnes of tomatoes (Melomey et al., 2019). Agro-processing, often known as food processing, is a sort of industrial food preparation that involves preserving, warehousing, and distributing agricultural goods in order to make them suitable for human consumption. The production of tomato paste is essential for the creation of jobs, the facilitation of rural development through industrialization, the generation of income for farmers and processors, the increase of government revenue and foreign exchange, and the significant reduction of post-harvest losses in tomatoes. Since tomatoes were first brought to Ghana, the processing of tomatoes has been a routine part of everyday life in the nation. Tomato paste is an essential component of many Ghanaian cuisine sauces, and the country relies greatly on this commodity. To date, Ghana has been recognised as the world's second-largest user of tomato paste (Baba et al., 2013). Ghana's annual production of fresh tomatoes amounts to roughly 510 000 metric tonnes,

while the country imports approximately 7000 tonnes of tomato paste from Europe (Baba et al., 2013).

The government of Ghana, upon making a critical observation in the early 1960s, realised that the country at that time depended a lot on the importation of tomato paste and sugar. As a result, the government of Ghana instituted the policy of import substitution in order to reduce the country's dependency on importation produce that can equally be produced locally. In order to facilitate the manufacture of tomato paste, three processing units for tomato paste were constructed. During the late 1980s, a multitude of factors contributed to the untimely demise of these processing operations. The failure of the tomato processing factories was mostly caused by frequent breakdowns, antiquated technology, a shortage of spare parts, bad marketing, a lack of technical competence, financial management, and structural changes implemented by the World Bank and the International Monetary Fund (IMF) (Robinson and Kolavalli, 2010a; 2010b, 2010c). The tomato disease complex was another issue that hindered the operations of tomato processing factories in Ghana. These plants were located in Ghana. As a result of advances in technology for agricultural equipment, acquiring high-quality gear for use in processing facilities is not nearly as difficult as it formerly was. It is essential for the continued functioning of a

processing plant that raw materials be continuously supplied to the processing plants so that the operation may continue.

The origin of the tomato may be traced back to the Andean area, which now includes Bolivia, Chile, Colombia, Ecuador, and Peru (Peralta and Spooner, 2007). On the basis of empirical theory, Mexico is generally accepted as having been the place where the tomato was first domesticated, but Peru is regarded as the centre of tomato diversity (Larry et al., 2007).

The processing of perishable agricultural food assists in increasing the shelf life of produce via value-addition, increases the income levels of farmers, and substantially minimises post-harvest losses (Chengappa, 2004). According to a study published by the United Nations Industrial Development Organization (UNIDO) in 2007, successful agro-processing companies account for between 40 and 60 percent of the processing value and make up a substantial portion of exports. The transition from an agricultural state to an industrial state is essential to the economic development of a nation (Khosla & Dhillon, 2015). Lycopene is responsible for around 83 percent of the total red pigments in a tomato (Gould, 2013), and the presence of lycopene in tomatoes contributes to a reduction in body weight (Bielig and Werner, 1986). Humans who consume a diet high in lycopene may be less likely to develop cardiovascular disease and a variety of malignancies (Arab and Steck, 2000). Consumption of tomato-based items on a regular basis, such as sauce, pizza, and juice, lowers an individual's risk of developing illnesses such as prostate cancer (Giovannucci et al., 1995). When compared to fresh tomatoes, canned tomatoes and ketchup have a much higher lycopene content because the cell walls are broken down during the high temperature cooking process, which results in an increase in lycopene levels (Nguyen and Schwartz, 1998). Tomatoes that have been processed are easier to handle and distribute, both of which are important factors in successful marketing (Naika et al., 2005). Gives rise to the possibility of labelling, which, in turn, will attract customers and give them a flavour that is both fresh and improved (Naika et al., 2005).

In the 1960s, when the then-Yugoslavian firm created three state-owned food processing industries in 1967, full tomato paste production began. The establishment of this enterprise for the processing of tomato pastes was done with the goal of reducing the significant amount of tomato paste that was imported. These factors contributed to the plant closures (Deha, 2018; Goodman, 2016). In addition to these problems, at that time, farmers in Ghana were unable to provide processing facilities with raw tomatoes in a continuous manner, which led to the factories' closure for the most part. The processing factories need to have a regular and timely supply of fresh tomatoes in the appropriate amount in order for them to be able to continue operating in a sustainable manner. Although the current government in Ghana has begun the process once more under the one district one factory policy, previous governments in Ghana have made numerous attempts to modernise these processing plants in an effort to cut down on post-harvest losses, raise the income of farmers, and make tomato paste easily accessible on the country's markets; however, these goals have not been achieved.

Although it is not yet operational, the new tomato processing facility may be found at Doryumu in the Shai Osudoku District of the Greater Accra Region. The plant was just built. An improvement in Ghana's tomato processing industry would result in a reduction in the country's imports of tomato paste, a rise in foreign currency, the generation of employment, the provision of chances for growth, and a diminution in massive post-harvest losses (Baba et al., 2013).

Pwalugu Tomato Processing plant right from the beginning faced a lot of problems such as tomatoes were inappropriate for processing due to inadequate percent total solids (dry matter), lesser soluble solids (Brix) (Grayson, 1973; Apte et al., 1969), inadequate plant equipment (Weitenberg, 1974), expensive running cost at that time because there were yet to be hooked –up to the national grid, which was later completed in 2008 (Ministry of Finance, 2008), poor management (Grayson, 1973). TOMACAN-Wenchi Tomato Processing plant in the late 1980s was not operational due to farmers' inability to access markets at peak tomato harvesting season. Farmers, especially in the Dormaa District, sold to La Cote D'Ivoire to earn more profit. Farmers upon contractual agreement were able to supply tomatoes to the processing plant and later diverted to sell directly to the fresh tomato market when tomatoes were scarce and more expensive in the markets than the processing plant fresh tomato price (Robinson and Kolavalli, 2010).

The Influence of Tomato Paste Imports on Ghana's Economy

According to a research that was published by Third World Network (2006), the introduction of tomato paste imports into Ghana has had a severe impact on the livelihoods of tomato growers, dealers, and workers in the tomato processing business. The price stability of tomatoes in Ghana is impacted by the amount of tomato that is imported. Because of the importation of tomato paste, it is challenging to establish employment opportunities throughout the tomato value chain in Ghana, particularly because of the increased importation of tomato paste that has been contaminated (The Ghana Report, 2019). In 2019, the Food and Drugs Authority revealed that there were 16 varieties of tomato paste that were harmful to human beings owing to the presence of credible compositions of substances such as starch and colorings in the product that were not contained on the labels of those varieties. According to Ghanawen (www.ghanaweb.com), in 2019, these tomato brands, numbered 16, were labelled fully unwholesome due to the fact that their composition was found to be demonstrated to be possibly detrimental to human health. The safety of food is a big issue all over the world, particularly with relation to the importation and local production of food goods. Not only does the production of tomato paste in Ghana under local food safety procedures and the stringent monitoring supervision of Ghana's Food and Drug Authority provide employment opportunities, but it also reassures customers that their food is safe to consume. The local production of tomatoes in Ghana has increased significantly over the past few years. However, in order to significantly reduce the amount of tomato paste that is imported into Ghana, it will be necessary to make

substantial investments in either updating existing processing facilities or constructing new ones.

2. PASTE PRODUCTION

In order to process tomatoes, collected matured fresh tomatoes that are completely free from impurities and bruises and have ideal quality qualities are picked for processing. After this has been completed, the tomatoes will need to be weighed in order to establish the tomato's overall quality. The mixing of the components is another factor that contributes to establishing the product's homogeneity. The tomatoes are then put through a sorting process. The colour as well as the degree of ripeness are important criteria in this case. Tomatoes that are spoiled or have been tainted in some way are separated from the healthy tomatoes so that only the latter may be processed. After the tomatoes have been sorted, they are given a thorough washing using a portable water source in order to eliminate any foreign contaminants that may have been mixed in with the tomatoes. A specialised equipment is used in the washing of the tomatoes. Following the washing step, the tomatoes are crushed into a pulp, which is then filtered. After that, the tomatoes are preheated in water that has been brought to a boil for about five minutes. It is essential that the tomatoes be completely submerged when they are in the boiling water. When the appropriate time has arrived, the tomatoes are taken from the oven and chilled by having cold water swiftly poured over them. This helps remove any unpleasant odour as well as aids in removing the peel and seeds from the fruit. Following the pre-heating step, the pulp is concentrated with the use of a heat exchanger. The concentration of the pulp takes place in a very short amount of time in order to avoid the result of the processing becoming a dark reddish colour. After that, the concentrate is homogenised, and flavouring, along with maybe some spices, are added to give it its organoleptic features. After that, boiling water is used to pasteurise the tomatoes. At this stage, both the bottle and the product need to be at the same temperature in order to continue. The process of pasteurisation may be completed after forty-five minutes. The finished tomato paste is then placed in cans or films for long-term storage and transportation to various market hubs.

3. DISCUSSION

Plants have a life cycle that may last anywhere from 100 to 120 days, depending on the specific qualities of the tomato variety and the environmental circumstances (Rocco and Morabito, 2016). The type of tomato that is chosen to be grown should have a large yield, a high demand in the market, mature quickly, and have a thick pericarp so that mechanical harvesting can be accomplished more easily. Specific climates bring out the best in certain kinds thanks to their adaptability. It is essential that the variety be resistant to viruses, and careful attention must also be devoted to the control of pests (Ha, 2015; Tran, 2005). When it comes to processing tomatoes, choose a tomato type that has a high concentration of soluble solids will provide the greatest results. When it comes to processing tomatoes, the amount of soluble solids represents a highly essential and crucial industrial characteristic. When choosing a tomato variety for processing, it is necessary to take into account both the

agronomic characteristics (early maturing, yield, resistance to disease, weed, and drought, etc.) and the industrial characteristics (pulp colour, soluble solids content, firmness, etc.). The agronomic characteristics include early maturing, yield, resistance to disease, weed, and drought, etc (Rocco and Morabito, 2016).

Farming on a Contract Basis

Contract farming is a form of vertical integration in which farmers are responsible for both the production and supply of agricultural goods. The goal of contract farming is to provide agricultural commodities of a particular quality and quantity at a particular price at a specific time in accordance with the terms of a contractual agreement (Singh, 2002). The timely delivery of agricultural raw materials at the appropriate quality and quantity may be facilitated via the use of contract farming (Kumah, 2015). A contractual agreement can be agreed upon between the facility management and the farmers in the surrounding area who supply produce to the processing plant in order to ensure continuity in the supply of fresh tomatoes to the processing plants. This will ensure that the processing plants never run out of fresh tomatoes. Farmers may be provided with agro-inputs, and then after harvesting their crops, the specific costs spent can be calculated and subtracted from the total quantity; the amount that is left over is the profit the farmers earned. Due to the fact that wholesalers and retailers are always seeking for possibilities inside the supply chain systems, this may therefore be maintained via the use of legal backing.

Farms operated for profit

In more recent times, Ghana's agricultural structures have grown more commercialised, which has resulted in an increase in the country's overall food production capability (Yaro et al., 2018). The establishment of commercial farms can be of assistance in the provision of raw materials that are brought directly into the plant. In accordance with this method, tomatoes may be harvested anywhere from twice to thrice every year if the necessary preparations are made. This will guarantee that the facility is supplied with tomatoes on a constant basis.

Outsourcing

In order to maintain a constant supply of tomatoes for processing at the plant, it is possible to get tomatoes from different producing areas or regions. Transportation will entail a significant amount of expense, and there is a risk that tomatoes may suffer from mechanical damage in addition to being contaminated.

Logistics

The movement of goods, their storage, and their administration are all aspects of the logistics process. It is necessary to organise the production in order to guarantee the smooth transit of agricultural goods to the processing facility as well as to the end customers. Handling, processing, storing, and packing are all included in this category. It is vital to offer better transportation, handling, and storage logistics in order to retain the quality of tomatoes and prevent post-harvest losses in tomato crops since tomato fruits have a very short lifetime. This is due to the fact that tomato fruits only live for a few days (Negi and Anand, 2015). The agro-processing industry in

developing nations is faced with a large number of logistical-related issues, despite the fact that effective logistical management plays an essential role in ensuring the longevity of the agro-industrial sector (Johnson et al., 2015). It is necessary to have an effective infrastructure in order to handle every product delivery at the appropriate time and with the appropriate level of quality.

Management of the facility

In order to effectively manage the day-to-day operations of the processing plant, the factory must be staffed by qualified specialists. Training and retraining opportunities are required for technicians as well as anybody else who participates in the value chain activities associated with tomato processing. To guarantee the processing of excellent products that are up to international standards, stringent adherence to all processing procedures must be maintained at all times.

4. CONCLUSION

In this review, the an investigation on mechanical & biological property of SiO₂ & Zirconia with epoxy polymer and application in Bioimplant have been discussed. In addition, we study the different materials mixed with epoxy but when silicon dioxide are mixed with epoxy then mechanical property are increased. When sio2 percentage are 4% of weight then max strength and max flextural strength is obtained. When % of sio2 are incredad like as 6, 8 % then mechanical property decreased gradually. Some research paper shows that the zirconia is best material for the applications of bioimplant and when zirconia are used for the mixing of epoxy polymer araldite 106 and hardner HV953IN then we find out the improved strength at any %.and its also used in biomedical application. In this review paper we conclude that when mixed the Sio2 and Zro2 in different percentage and its further mixed with epoxy polymer then we find out the max strength and then it is used for bioimplant. From literature it is found that the use of zirconia is very high for biomedical areas.

Tomato processing generates a lot of income to the processors and also reduces high post- harvest losses in tomatoes. Processing of tomatoes into paste form can earn Ghana foreign exchange. This will help in reducing post-harvest losses and make Ghana self-sufficient in the processed tomato products industry by reducing importation of tomato paste. This will bring more revenue to the country. Sustaining tomato processing will help in extending the post-harvest life of tomato and increase its accessibility. The processing plants when revamped will increase the food security capacity of Ghana.

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