A MINI REVIEW ON THE MICROBIOCHEMICAL PROPERTIES OF SAUERKRAUT.

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Abstract
The increasing toxicologic profile as well as the absence of cost-effective allopathic therapeutic regimes has posed a great threat to the global health security. As dietary supplements are the most consumers’ acceptable therapeutic moieties used to mitigate malnutrition-induced diseases, this study was carried out to develop a probiotic lacto-fermented sauerkraut. The sauerkraut was produced using cabbage containing lactobacilli starter cultures under standard physicochemical conditions of temperature, absence of oxygen, salt addition and acidity. The pH, acidity, bacteriological and organoleptic parameters during the fermentation process were evaluated. The results obtained from this research portrayed that the sauerkraut prepared under standard physicochemical conditions of temperature, absence of oxygen, salt addition and acidity as well as microbiological conditions such as the presence of Lactobacilli starter cultures, could be a promising nutraceutical for the treatment of malnutrition-induced diseases.
Keywords: Nutraceutical, cabbage, probiotic and sauerkraut.

INTRODUCTION
Fermented food plays a crucial role in providing food security, enhancing livelihoods and improving nutritional and social wellbeing of many. The fermentation of vegetables could be affected by several groups of microorganisms. The nature of vegetable has paved way for their fermentation due to bacterial, fungal and enzymatic activities.

Salting and fermentation in vegetable processing are related. Although the total number of fermented vegetable available in the market is unknown, only cabbage for sauerkraut, cucumbers for pickle and olives, gain economic importance presently. The name Sauerkraut is literally translated as acid cabbage and it is widely consumed in the central and southern parts of the United States.

The most significant property of probiotic microbes is their ability to produce lactic acid moieties from fermented diary products. The discovery of an array of the rudiments of bacteria-induced fermented dairy products consumption has led to several investigational studies on the functional properties of microbes (Yu, et al., 2013).

Sauerkraut has many health benefits offered by the cruciferous vegetables such as cauliflowers, brussel sprouts and cabbage, with the probiotic benefits derived from the fermentation process possibly due to the lactic acid bacteria (Lactobacilli) produced as a by-product of the pickling process. Studies have shown that cabbage offers an array of health benefits such as inflammatory properties, reducing cholesterol in dyslipidaemia, provides a rich source of phytonutrient antioxidants, vitamins A and C. In China, sauerkraut juice has been prescribed traditionally as a domicile remedy for some ailments. The Roman army travelled with barrels of sauerkraut during long excursions for the prophylaxis of intestinal infections. Also, studies have shown that a substance produced by fermented cabbage, isothiocyanates, could play a role in the prophylaxis of malignant neoplasms (Yu, et al., 2013).

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The fermentation of cabbage has been shown to enhance its protective activities. The glucosinolatemoieties in sauerkraut induces the body’s antioxidant enzymatic activity and the flavonoid components confer protection to blood vessels from oxidative damage. Also, lacto-fermented sauerkraut provides an array of lactobacilli probiotics, vitamin C, dietary folates, manganese and pyridoxine (http://www.pickl-it.com/blog/202/sauerkraut/wonder-food/).

Healthy colons of humans contain some beneficial bacteria which feed on digestive wastes, thereby producing lactic acid. Without these beneficial bacteria, the digestive tracts become a thriving zone for pathogenic bacteria and yeasts, resulting in candidiasis. However, it is suggested that the consumption of lacto-fermented sauerkraut could help re-establish lactobacilli-opportunistic infective agents equilibrium.

METHODS
The preparation of Sauerkraut as described by Kuri (2003) is showed below. First and foremost, the cabbage was washed and trimmed so that the outer green, broken and dirty leaves are removed. Then, they were shredded in long, thin shreds according to preference and dry salt was added according to specifications. Once filled into containers, they were covered with a plastic sheet to seal against the wall of the container. Weight was applied and they were allowed to ferment at 18°C for four weeks. During this fermentation process, the acidity of the fermentation medium was evaluated at intervals until the final fermentation product was obtained.

RESULTS

<table>
<thead>
<tr>
<th>PH</th>
<th>Salt + starter (Container A)</th>
<th>Salt with no starter (Container B)</th>
<th>No salt, no starter (Container C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial pH</td>
<td>6.18</td>
<td>6.18</td>
<td>--</td>
</tr>
<tr>
<td>Final pH</td>
<td>3.8</td>
<td>4.54</td>
<td>4.68</td>
</tr>
</tbody>
</table>

Table 1: pH Level

Container A = Starter + salt
Container B = Salt with no starter
Container C = No salt no starter

DISCUSSION
Sauerkraut is an acidic cabbage obtainable from the natural fermentation by the bacteria intrinsic to cabbage (Campbell, G.,
The production of sauerkraut involves three phases: washing, salting and the elimination of oxygen. Since cabbage is in direct contact with soil or organic matter, washing helps to remove the cupious microorganisms that may be present. In the production process, the Sauerkraut is salted and the salt plays two roles. Firstly, it causes an osmotic imbalance which results in the release of water molecules and nutrients from the cabbage leaves. Secondly, the salt inhibits the growth of spoilage microbes and other pathogens.

As lactic acid bacteria start to produce slowly lactic acid, the environment becomes unbearable since most bacteria are acidophobic. A combination of salt and increased amount of lactic acids inhibits the growth of other bacteria and improves the stability of sauerkraut as the fermentation continues.

When the fermentioner is packed with cabbage, the microbes start competing for food. Some are inhibited by salt while others require oxygen for survival. Eliminating oxygen could be effected by packing the fermentioner hard with shredded cabbage, slicing cabbage thinner, keeping cabbage submerged in brine using weights or using water channel fermented crocks or airlock glass jars. (http://www.foodpreservationmethods.com/sauerkraut-fermentation).

From the table above, it shows that container A undergone a proper fermentation compared to B and C, with respect to the final pH. This could be due to the presence of the salt and starter cultures. The fluid expelled from the leaves is an excellent microbial growth medium needed for the fermentation process in container A. After the salting-out process, the substrate obtained accelerates the fermentation process whereas the process is impeded in container B and C.

The fermentation process of Sauerkraut involves a cascade of complex interactive microbiological, biochemical, enzymatic and physiochemical reactions. Once cabbage is placed in a fermentioner, gas-evolving microbes such as Leuconostocmensenteroides initiate acid production. At a much lower level of acidity, which is the lactic acid range, the growth of cocci begin to slow down and eventually die off. However, the enzymes released by them via autolysis remains and continues during the fermentation process. As the acidity approaches 0.7-1.0%, all the cocci have completely disappeared. At this point, Lactobacillus plantarium and L. brevis then increase acidity to 1.5-2.5% regardless the inhibitory effect of the salt and low temperature. A final acidity level of 2.0-2.5% is reached by Lactobacillus sake and Lactobacillus curvatus to complete the fermentation process (Wilson H., 1988). The end product of cabbage prior to fermentation contains a significant amount of lactic acid, minute doses of acetic acid, propanoic acid, carbon dioxide and most importantly, alcohol and a mixture of aromatic esters. It is suggested that the acid-alcohol complex forms aromatic esters, which give flavour to Sauerkraut (Kuri V., 2003, Wilson H., 1988).

CONCLUSION

The production of a novel nutraceutical for the treatment of different ailments arising from nutrient deficiencies was carried out. The results obtained from this research portrayed that the sauerkraut prepared under standard physicochemical conditions of temperature, absence of oxygen, salt addition and acidity as well as microbiological conditions such as the presence of microbial starter cultures, could be a promising nutraceutical for the treatment of malnutrition-induced diseases. Also, it could be suggested that the consumption of lacto-fermented sauerkraut could help re-establish lactobacilli-opportunistic infective agents equilibrium.

References

5) Wilson, H., (1988). Egyptian Food and Drink (Shire Egyptology), Thomas and Sons Ltd, Haverford West, UK.