[illegible] PROCESS OF HYBRID SWEET CORN (BIG FRUIT, 926) BY USING DIFFERENT TEMPERATURE HOT WATER TREATMENT

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MINIMALLY PROCESS OF HYBRID SWEET CORN (BIG FRUIT, 926) BY USING DIFFERENT TEMPERATURE HOT WATER TREATMENT

By
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ENDORSEMENT

The project report entitled **Minimally Process Of Hybrid Sweet Corn (Big Fruit, 926) By Using Different Temperature Hot Water Treatment** by **Azirah binti Akbar Ali** Matric Number **UK14902** has been reviewed and corrections have been made according to the recommendations by examiners. This project is submitted to the Department of Agrotechology in partial fulfillment of the requirement of degree of Science in Agrotechnology (Post Harvest Technology) Faculty of Agrotechnology and Food Science, Universiti Malaysia Terengganu.

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ABSTRACT

Sweet corn known as maize and its binomial name *Zea Mays.* This study was conducted to determine the effect of different storage temperature on the shelf-life of minimally process of sweet corn. The hybrid sweet corn (Big Fruit, 926) were obtained from Jabatan Pertanian Kuala Berang,Terengganu. Sweet corns are divided into 4 treatments; T1: control, T2: 30°C, T3: 40°C and T4: 50°C. All the treatments were stored in temperature 5 ± 1°C. The analyses involved physical analysis including texture, weight loss and color changes while chemical analyses are Total Soluble Solid (TSS) and Titratable acidity (TA). The statistical analyses were done by using SPSS version 16. There was no significantly different ($P>0.05$) for all treatments in texture (firmness), color changes, Total Soluble Solid (TSS), Titratable Acidity (TA) but there was significantly different ($P<0.05$) for weight loss. This is a new report on minimally processed of hybrid sweet corn for variety Big Fruit (926).

ABSTRAK

Jagung manis dikenali dengan nama saintifiknya *Zea Mays*. Kajian ini dilakukan untuk melihat kesan jagung manis yang disimpan pada suhu 5±1°C setelah melalui rawatan air panas. Jagung Manis hibrid (Big fruit, 926) diperolehi dari Jabatan Pertanian Kuala Berang,Terengganu. Sebanyak empat rawatan dibuat iaitu T1: kawalan, T2: 30°C, T3: 40°C dan T4: 50°C. Analisis yang dilakukan adalah analisis fizikal iaitu pengujian tekstur, analisis kehilangan berat, dan perubahan warn. Bagi analisis kimia pula merangkumi perubahan jumlah pepejal terlarut dan perubahan asid tertitrat jagung. Akhir sekali data-data dianalisis menggunakan SPSS edisi 16. Semua jagung tidak menunjukkan perubahan ketara (P>0.05) tetapi terdapat perubahan yang ketara (P<0.05) pada kehilangan berat buah. Ini merupakan kajian terkini berkenaan proses minimal bagi Jagung manis variety 'Big Fruit' (926)

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LIST OF ABBREVATIONS

a*	:	a value for chroma meter
b*	:	b value for chroma meter
CA	:	controlled atmosphere
g	:	gram
mg	:	miligram
ug	:	microgram
kcal	:	value for energy
min	:	minute
HWT	:	hot water treatment
MPF	:	minimally processed food
PPO	:	polyphenoloxidize
ha	:	hectare
s	:	second
W	:	weight
ANOVA	:	analysis of variance
SSC	:	sucrose phosphate synthase
TSS	:	total soluble solid
SPS	:	sucrose phosphate synthase
mm	:	milimeter
L*	:	skin lightness
°C	:	degree celcius
%	:	percentage
SPSS	:	Statistical Package for Social Science
TA	:	titratable acidity

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Sweet corn also known as maize and its binomial name *Zea Mays,* is a tall cereal plant consisting of strong jointed stems supporting large ears containing kernels. There are different types of corn grown and sweet corn is one of the most popular varieties for human consumption. Sweet corn is a good source of vitamin A, magnesium, potassium, and is often considered to be a vegetable rather than a grain. When harvested at the proper ripeness, the kernels of sweet corn are tender and have a sweet, juicy taste. Sweet corn can be processed into syrup, sugars that can be used as sweeteners in soft drinks, starch, and cereals. In Malaysia, there are many varieties of sweet corn that had been cultivated such as Suwan1C7, Suwan 3, Jagung Manis, Thai Super sweet, Manis Madu, and Masmadu (Jainuddin, 1984).

Nowadays, consumers demand food which retain their natural flavor, color, texture and contain fewer additives such as preservatives. In response to the needs, the food industries keep on developing the minimal processing technologies and design. This will also limit the impact of processing on nutritional and sensory quality. Minimal processing generally consists of washing, cutting, treating with sanitizing agents, packaging and finally storing under refrigerated conditions (McKellar *et al*., 2004). The peeling and cutting processes will caused break-down of the cell walls, loss of intracellular substances and enzymes and finally damage the vegetable tissues. Minimal processing gives additional value to fruits and vegetables in terms of convenience and time saving.

Fresh cut (i.e., lightly processed, minimally processed) identifies fresh vegetables that have been cut into small serving-size portions and are ready to eat example broccoli (*Brassica oleracea* L. Botrytis group), carrots (*Daucus carota* L.), lettuce (*Lactuca sativa* L.), spinach (*Spinacia oleracea* L.) or to cook such as artichokes (*Cynara scolymus* L.), sweet corn (*Zea mays* L.) (Saltveit, 1997; Schlimme, 1995; Shewfelt, 1987, Stanley, 1998). Consumption of fresh cut vegetables is rapidly increasing and new products are continually being developed. Demographic changes over the next few decades, to further increase the demand for fresh-cut vegetables. Consumers are becoming increasingly and concerned about nutritive quality of their diet. The ease of use of fresh-cut should also significantly improve the diet through promotion of the consumption of vegetables (Bruhn, 1995).

Hot water treatment can be applied in minimally processing by immersion, brushing or rinsing the produce. It kills the pathogens that cause fruit decay and extended the shelf life of the produce (Lurie, 1998). The treatment usually takes about 10-30 seconds and with recycled hot water (50-65°C), depending on the produces. Couey (1989) and Lurie (1998) also had mentioned that this treatment has a number of advantages which include relative ease of use, short treatment time, reliable monitoring of fruit and water temperatures, and it kills of skin-borne decay-causing agents.

On the other side, fresh cut or minimally process produces are usually stored in controlled atmosphere (CA) and Modified Atmosphere (MA) at which the gas composition surrounding the commodity is different from the air such as 78.08% nitrogen gaseous, 20.95% oxygen, 0.93% argon and 0.03% carbon dioxide (Kader, 1986). In practices, CA and MA usually involve reducing oxygen (O_2) levels below 5% and elevating carbon dioxide (CO_2) levels above 3%. With low composition of oxygen (O_2) and high of carbon dioxide (CO_2) atmospheres together with low storage temperature will reduced product respiration rate and, the quality of the produces are protected (Watada, *et.al* 1996). In addition, there are many types of packaging that are used to pack the produce after minimally process. The most commercial packaging is by using plastic wrap or known as polyethylene plastic.

1.2 Problems Statement

Minimally processed of sweet corn is very uncommon and there are lacks of publication on hybrid sweet corn variety Big Fruit 926.

1.3 Significant of study

Study the effect of Hot Water Treatment (HWT) towards minimally processing of sweet corn and finally to determine the proper HWT that can sustain the produce quality and also prolong the hybrid sweet corn shelf-life.

1.4 Objectives

1. To study the effect of hot water treatment on minimally processing of sweet corn (*Zea mays*)
2. To determine the effect of different Hot Water Treatment temperature on the shelf life of sweet corn *(Zea Mays)*

CHAPTER 2

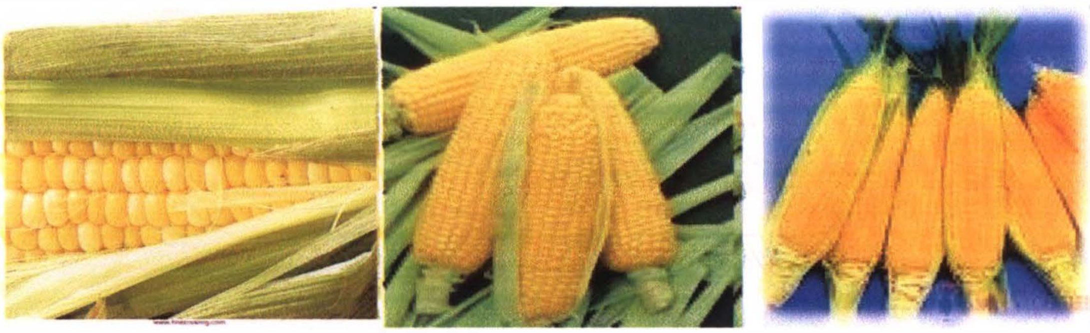
LITERATURE REVIEW

2.1 Sweet corn

Zea mays is a monocotyledon plant of grass family, Graminae. It is in the same group as barley, oat, paddy and wheat. Corn was first brought into Malaysia through Melaka by the invading Portuguese and the Dutch for fresh consumption. It was the Flint and Dent types of corn (Wong, 1992). The first sweetcorn variety bred in Malaysia was released in 1974 (Graham and Yap, 1972) and the supersweet corn variety was introduced and planted in 1981 (Lee *et al.,* 1983). Then it starts to develop and more varieties produce when corn are taken as food consumption and animal feed. Until today, the research about corn is still on going and many efforts are taken to make effective development of corns. It has many varieties after Flint and Dent such as Supersweet corn, Masmadu and Manis Madu (Jainuddin, 1984). Corns are harvested at day 68-72 after plantation (Ismail *et al.*, 1984) manually by using hand to pick it. After harvested, corns are stored in temperature 3-5°C within 24-36 hours store until three weeks (Jainuddin, 1984).

There are many varieties of corn such as cereal corn, sweet corn, Suwan 1C7, Suwan 3, Thai Supersweet, Manis Madu and Masmadu (Jainuddin, 1984) and not all varieties were planted in Malaysia. The development of varieties is according to the uses of the corn for human consumption. The first locally bred sweetcorn variety was Cinta (Graham and Yap, 1972), followed by Bakti-1 (Yap and Halim, 1979). These composite varieties were developed by composition of the products of the diallel crosses of the parents, followed later on by mass selection for healthy and disease-resistant plants in the field and for sweetcorn type kernels during seed processing. Kernel sweetness of these varieties is under the control of *su* genes (Coe *et al.,* 1977). Kernel sweetness diminishes rapidly after harvest for Cinta and Bakti-1; therefore these varieties were not widely planted. Later in 1981, Thai Supersweet was introduced in Malaysia (Lee *et al.,* 1983) (Figure 2.0a) and this variety replaced most the traditional cultivars for fresh cob production. The rapid acceptance of this variety by farmers may be attributed to its superior quality and high yield. However, the kernel color of this variety was not very attractive and was a mixture of yellow, orange and red (Coe *et al.,* 1977). A selection programme was initiated in 1983 to select for a more uniform kernel color. One of the results of this programme was a yellow-kernelled population called Supersweet kuning (Lee *et al.,* 1986). This variety was later named and released as Manis Madu (Figure 2.0b).

Masmadu was developed from a cross between Honey Jean No.2 (*sh* gene) and Across 7824, a grain corn variety for tropical adaptation and disease and pest tolerance. (Lee *et al.,* 1990) This variety has golden yellow kernels, honey sweetness, larger cobs, and better tolerance to leaf diseases and is more adaptable to the tropical environment of Malaysia (Lee *et al.,* 1990) (Figure 2.0c). The latest variety that develops after Masmadu is Improved Masmadu. It is a variety developed by re-selection from the original Masmadu population. This corn has uniform light yellow kernel and slight improvement plant type (Abdul Wahab and Hashim, 1994). All the Supersweet varieties produced locally so far are open-pollinated varieties and based on the *sh2* gene (Lee *et al.*1986). Now, two latest varieties had been introduced and showed high demand by consumers which are hybrid sweetcorn, sweet melody (969) and big fruit (926) (Hamidah, 2009)



a b c

Figure 2.0: (a) Thai Supesweet (b) Manis Madu (c) Mas Madu

All the varieties produced dark green lamina leave colour and growth until 200cm height with cob for both Thai Super sweet and Manis madu is 100cm while Masmadu 105cm (Lee et al.1983). Based on the 1994 data, the yield potential for Thai Super sweet and Manis madu is 30,000 cobs within 13ha plantation and 17ha for Masmadu. Therefore, Thai Supersweet and Manis Madu will be better choice for farmers in terms of quality and quantity of yield. Table 2.0, listed the nutrient composition for a 100g corn.

Table 2.0 The nutrient composition for 100g corn

Nutrient	Amount
energy	90kcal (360KJ)
Protein	3.g
Fat	1.2g
Carbohydrate	19g
Sugar	3.2g
Dietary fiber	2.7g
Iron	0.5mg (4%)
Magnesium	37mg (10%)
Potassium	270mg (6%)
Folate (vit B9)	46ug (12%)
Vitamin A	10ug (1%)
Vitamin C	7mg (12%)

Source: Anonymous (2009)

2.2 Minimally processed sweet corn

The term minimally processed vegetables can be applied to any fresh vegetables that has been physically altered from its original form, but remaining a fresh state (Gomez-Lopez *et al*., 2008). It has been trimmed, peeled, washed and cut into a 100% usable product that is subsequently bagged or pre-packaged (IFPA, 2009). Fresh-cut vegetables have emerged to fulfill consumer demands for healthy, palatable and easy to prepare plant foods (Allende *et al*., 2006). The study of minimally processed have been done for super sweet corn variety by Oklahama State University in 1994. The sweet corn was cut into cobs and stored at -20°C in blanched or unblanched form and the evaluation are done every 4 months for a year for quality. All corns were frozen with liquid carbon dioxide and samples are bagged in polyethylene bags and stored in waxed boxes at -20°C. Early, result showed the sucrose percentage was higher in unblanched samples. The ends result indicated that unblanched supersweet corn can store until 8 months and after 12 months of storage, blanched samples were more acceptable in taste than unblanched samples (Perkins *et al.*, 1994).

2.3 Treatments of Minimally Processed Products

Treatments have been developed to prolong the postharvest life of vegetables while maintaining acceptable market quality. Temperature control and use modified atmosphere (MA) and controlled atmosphere (CA) are among the most important techniques for maintaining vegetables quality after harvest. Other treatments that also can be included is used of waxes or other edible coatings, use of compounds to control spoilage organisms, and chemical treatments to retard ripening, senescence, sprouting, and undesirable color and texture changes.

2.3.1 Physical treatments

2.3.1.1 Hot Water Treatments

Hot water treatments (HWT) have been shown to effectively reduce human pathogens and native microflora on whole cantaloupes (Annous *et al.*, 2004). Prestorage heat treatments to control decay are often applied for a relatively short time within a few minutes, because the target pathogens are found on the surface or in the first few cell layers under the skin of the fruit or vegetables (Lurie, 1998). Heat may be applied to fruit and vegetables in several ways such as hot water dips, vapor heat, hot dry air (Lurie, 1998), or by hot water rinsing and brushing (Fallik *et al.*, 1996 and Fallik *et al.*, 2001a). The treatments will killed the pathogens that cause surface decay, while maintaining fruit quality during prolonged storage and marketing. The cost of a typical hot water technology commercial system is significantly less than commercial vapor heat treatment system. The hot water treatment is usually apply at temperatures between 43°C and 53°C for periods of several minutes up to 2 hour for quarantine treatments. Water is preferred for most applications since it is more efficient heat transfer medium than air. Heat treatments can also be used to inhibit ripening processes or to induce resistance to chilling injury and external skin damage during storage, thus extending storability and marketing (Woolf, 1997; Lurie, 1998 and Paul and Chen, 1999).

Hot water treatment of 49°C for 20min was approved by USDA-APHIS for several tropical fruit such as papaya, litchi or carambola from Hawaii (Follet *et al*, 2001). Immersing apple fruit at 80°C and 95°C for 15s produced a reduction of *Escherichia coli* (Fleischman *et al.* 2001). By dipping minimally processed green onion into hot water for 2 min at 55°C or 4 min at 52.5°C was the most effective means to control extension growth and enhance microbial disinfection, while maintaining the bright green color of the leaves during storage (Cantwell *et al.,* 2001). Park *et al.*, (1998) had reported a reduction in microbial populations in soybean sprouts with a 30s hot water dip at 60°C. Outbreaks of foodborne disease involving enteric pathogens such as enteropathogenic *E.coli* have also been documented. So, this HWT can be used to minimize and prevent the sweet corn from pathogen contamination.

2.3.1.2 Edible Coating

Synthetic and natural waxes and resins have been used to coat fresh fruits and vegetables since the 1930 (Platenius, 1939), mainly for control of water loss and improve appearance. However, recent consumer interest in nutrition, food safety, and environmental concerns has revitalized efforts in edible coating research. Edible coating film formers can include lipid, resin, protein and carbohydrate compounds, used alone or in composite formulations. The petroleum-based waxes and oils used in coatings for vegetables are paraffin wax, polyethylene wax, and mineral oil (Hernandez, 1994). Proteins such as casein from milk and zein from corn have been used as edible coating for vegetables such as peeled carrots (Avena-Bustillos et al., 1993) and tomatoes (Park et al., 1994). Vegetables have natural waxy coating, called cuticle, and made up of fatty acid related substances (waxes and resins) with low water permeability. This waxy layer may be removed or altered during washing (Hagenmaier and Baker, 1993a), resulting in increased water loss and subsequent weight loss in uncoated commodities. Edible coatings can help retard this movement of water vapor (Hagenmaier and Baker, 1995), but they become more permeable to water vapor and gases under conditions of high relative humidity because water acts like a plasticizer. Wax and oil coatings have been shown to retard desiccation of many vegetables. If pores, cracks, or pinholes occur in the film surface, mass transfer of water vapor through these areas may be much more rapid than dissolving and diffusion of water vapor through a film barrier (McHugh and Krochta, 1994).

2.3.1.3 Packaging

Fruits and vegetables are living, respiring and perishable products with active metabolism even after harvest from the parent plant. The storage life and quality of fruits and vegetables can be extended by modifying the atmosphere surrounding products (Kader, 1986). A modified atmosphere can be defined as one that is created by altering the normal composition of air (21% oxygen and 0.03% carbon dioxide) to provide an optimum atmosphere for increasing the storage length and quality of produce. Modified atmospheres can be achieved by using controlled atmosphere (CA) storage or modified atmosphere packaging (MAP) (Brody 1989). Modified atmosphere packaging (MAP) is not a novel topic; there are many excellent reviews of MAP and related technologies (Mathlouthi, 1994; Paine and Paine, 1992; Brody, 1989). However, due to consumer demands for fresh, close-to-fresh, or minimally processed foods (MPF), as well as the desire for more healthy, tasty, and safer foods, MAP has been elevated to a new degree of importance. High oxygen MAP treatment has been found to be particularly effective at inhibiting enzymatic browning, preventing anaerobic fermentation reactions and inhibiting aerobic and anaerobic microbial growth (Day, 1997). High oxygen levels may cause substrate inhibition of Polyphenol oxidase (PPO), or the high levels of colourless quinones subsequently formed may cause feedback production of PPO (Labuza *et al.,* 1992).

Carbon monoxide (CO) gas atmosphere has also been found to inhibit mushroom PPO eversibly (Labuza *et al.,* 1992). Achieving the right gas mixture is one of the most difficult tasks in manufacturing raw ready-to-use or ready-to-eat fruit and vegetable products. The main problem has been the lack of sufficiently permeable packaging materials (Day, 1994). Most films do not result in optimal oxygen and carbon dioxide atmospheres, especially when the produce has high respiration.

However, one solution is to make microholes of defined sizes and a defined quantity in the material in order to avoid anaerobiosis (Exama *et al*., 1993). This procedure significantly improves, for example, the shelf-life of grated carrots (Ahvenainen *et al*., 1994). Other solutions are to combine ethylene vinyl acetate with oriented polypropylene and low density polyethylene or to combine ceramic material with polyethylene.

Both composite materials have significantly higher gas permeability than polyethylene or the oriented polypropylene that is much used in the packaging of salads, even though gas permeability should ideally be higher (Ahvenainen and Hurme, 1994). These materials have good heat sealing properties and they are also available commercially (Ahvenainen and Hurme, 1994). The shelf-life of shredded cabbages and grated carrots packed in these materials is 7–8 days at 5°C and therefore 2–3 days longer than in the oriented polypropylene which is generally used in the vegetable industry (Hurme *et al*., 1994; Ahvenainen *et al*., 1994).

2.3.2 Chemical treatments

2.3.2.1 Sanitization

Chlorine dioxide (ClO_2) is one of the few compounds that exist almost entirely as monomeric free radicals (WHO, 2000). It is first used as disinfectant in the beginning of the 20th century, water disinfection in Belgium (Tzanavaras *et al.,* 2007). Most commonly used as bleaching agent in paper manufacturing, and in public water treatment facilities to make drinking water safer. In 2001, ClO_2 and chlorite were used to decontaminate a number of public buildings following the release of anthrax spores in United State (ATSDR, 2004). The interest in ClO_2 in decontaminant of vegetables is largely based on its efficacy, which is less prone to impairment under low pH and in the presence of organic matter, and its inertness towards ammonia to form chloramines (Beuchat, 1998).

2.3.2.2 Anti-browning

Antioxidants are compound that inhibit or prevent the oxidation reactions caused by free radicals, with or without oxidation enzymes that cause discoloration or browning of certain fruit and vegetable tissues and rancidity of fats (Sapers, 1993). This can affect the color or flavor of mushrooms and fruit and vegetable products. Some agents such as cinnamic and benzoic acids are effective browning inhibitors in combination with ascorbic acid, since they inhibit polyphenol oxidase (PPO) activity (Sapers et al., 1989). This enzyme is responsible for the browning that occurs when monophenolic compounds of plants are hydroxylated to *o*-diphenols and subsequently to *o*-quinones in the presence of O_2. The PPO enzyme requires copper, thus complexing and chelating agents such as ethylenediamine tetraacetic acid (EDTA) and citric acid can inhibit enzymatic browning (Sapers, 1993). Ascorbic acid and its derivatives such as erythorbic acid, ascorbic acid acid-2-phosphate and ascorbic acid-triphosphate are effective inhibitors of enzymatic browning for cut apple (Sapers et al., 1991).

CHAPTER 3

METHODOLOGY

3.1 Sample preparation

Freshly harvested sweet corns were obtained from Jabatan Pertanian Kuala Berang, Terengganu and brought to the post harvest laboratory for post harvest handling processes. Firstly, the leaves and hairs were removed and cleaned. Only good quality corns were selected for this project. Corns with physical injury because of handling process such as black kernel or abnormal corns were observed. This process also known as trimming process. The corns which have nice kernel arrangement, normal length, stiff kernel structure and without corn borer is classify as good characteristics corn. After trimming process, corns were washed with chlorine dioxide which give protection to the corns and prevent infections by microbial. Then, all corns were treated in four different temperatures which is 30°C, 40°C, 50°C and control (distilled water). Each treatments with 3 replicates were dipped for 30 minutes. Corns were packed in the styrofoam and wrapped with Polyvinyl Chloride (PVC) plastic (Figure 3.0). One cob in one Styrofoam to protect and also prevent any contamination. All corns were stored at 4-7°C and every 3 days data analysis were taken until 12 days. The analysed data according to the texture, color, titratable acidity, total soluble solid, and weight loss of the corns.

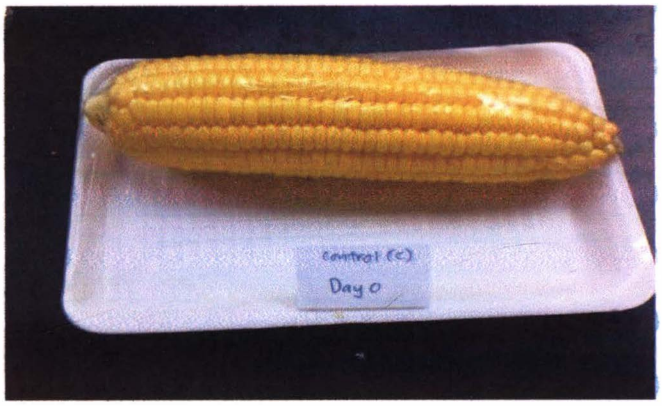


Figure 3.0: One cob was packed on polystyrene tray with cling wrap of sweet corn.

3.2 Parameters of Corn Analysis

Five parameters of analysis; color, texture, weight loss, total soluble solid and titratable acidity.

3.3.1 Texture

Changes in texture of sweet corn were analyzed by using Stable Macro System, TA. XT plus texture analyzer on day 0, 3, 6, 9 and 12. High firmness showed the high quality of the produce and vice versa. The texture analyzer needle penetrated to the middle of the corn and analyze the corn firmness. For sweet corn, probe P/2N cylinder stainless are used with pre test speed 1.0mm/s, test speed 0.5mm/s and post test speed 1.0mm/s. The analyses had been done for 5 different places in the kernel of sweet corn.

3.2.2 Total color changes

Color is a main important appearance for fruit and vegetables. Color is a critical quality parameter of cut apples that can limit the shelf-life considerably (Rocha and Morais, 2003). The assumption by consumers to the quality of the fruit and vegetables are analysis in color appearance. The color can change to abnormal color and it shows the low quality and rejected in market. The Chrome meter are used to determine the color value. In this analysis, the color had been observed on day 0, 3, 6, 9 and 12 and the data have been recorded. Total color changes were been determined by using below formula:

$$\sqrt{((L_o-L_n)^2 + (a_o-a_n)^2 + (b_o-b_n)^2)}$$

Where L_o, a_o, b_o are the color changes on the first day and L_n, a_n, b_n the color on day 3, 6, 9 and 12.

3.2.3 Titratable Acidity

The Titratable acidity of a solution is an approximation of the solution's total acidity. The titratable acidity of a solution is measured by reacting the acids present with a base such as sodium hydroxide (NaOH) and a few drops of phenolphthalein was used as an indicator. The formula to determine the percentage of citric acid or malic acid content in the corn as below:

$$(\%)\text{ malic acid} = \frac{\text{Titre} \times \text{normality of alkali} \times \text{volume made up} \times \text{Eq* weight(134mg)} \times 100}{\text{Volume taken for estimation} \times \text{weight of sample} \times 1000}$$

3.2.4 Total Soluble Solid Content (° Brix)

Total soluble solid is a study about the sugar content in the fruit and will be determined by using hand-held refractometer. The kernels were pick out from corn and cut into small pieces and put in a muslin cloth and then squeeze to get the juices. One or two drops of juice will be enough to put on the refractometer prism (before that refractometer is clean well with distilled water and wiped dry) and the reading (°Brix) are recorded.

3.2.5 Percentage Weight Loss

Weight loss study is a study about losses of moisture in the produce. It showed the percent losses in produce. Longer storage can cause the corns to lose its moisture. Thus, this analysis is to measure the percent of moisture losses of the sample corns. Finally, to compare the moisture losses in different treatments. Weight losses were been determined by using weight loss formula as below:

$$\text{Weight loss} = (W_o - W_n)/W_o \times 100$$

Where W_O is the weight on the first day and W_n the weight on on day 3, 6, 9 and 12.

3.3 Statistical analysis

The data collected from all the analyses were analyzed by using the analyses of variance (ANOVA). Significant difference ($p<0.05$) between treatments were compared by using Tukey Test. The statistical programmer used is SPSS version 16.0

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Texture (Firmness)

Vegetables are complex plants foods and it is important to define their textural characteristics because they are varying with composition and structure. The results for firmness are shown in Figure 4.1 and Table 4.1. The changes between treatment is not significantly different ($P>0.05$) in day 3. It showed significantly different ($P<0.05$) for all treatments from day 0 until day 3 but no significantly different ($P>0.05$) on day 12. From the observation, the sweet corns kernel shrinked and there was significantly different ($P<0.05$) for each treatments from day 0 to day 12. The mean value for control was decreasing in day 3 until day 6 and increasing in day 9 (Table 4.1). It can be due to deceased turgidity, thinning of cell wall, or increased cell size coupled with decreased tissue cohesiveness caused by degradation of pectin and cell disarrangement (Szezesniak and Smith 1969). Decreased crispness is some vegetables may be associated with folding of the cell wall and cytoplasmic disarrangement (Szezesniak 1988).

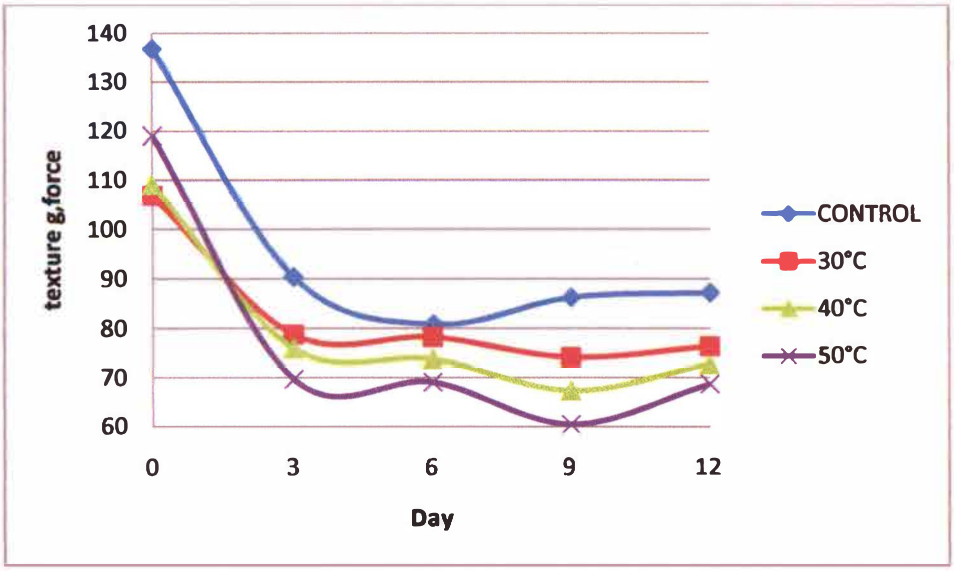


Figure 4.1: Effect of Hot Water Treatment (HWT) on the firmness of sweet corn during storage

Table 4.1: Firmness values for MP sweet corns.

TREATMENTS	DAY				
	0	3	6	9	12
CONTROL	1.37E2±36.12^{Bb}	86.27±29.55^{Aa}	80.83±22.39^{Aa}	90.36±28.54^{Aa}	87.18±20.85^{Aa}
30°C	1.03E2±15.62^{Ba}	78.23±37.96^{ABa}	78.77±16.36^{ABa}	74.16±24.38^{Aa}	76.39±27.09^{Aa}
40°C	1.09E2±39.75^{Bab}	81.28±17.57^{Aa}	77.54±15.03^{Aa}	67.32±24.28^{Aa}	72.70±26.42^{Aa}
50°C	1.19E2±33.98^{Bab}	60.45±22.94^{Aa}	69.07±20.64^{Aa}	69.67±23.05^{Aa}	68.68±18.74^{Aa}

Note values in table 4.1 are mean of 3 replicate (3 representative sample/replicate) (Mean n=9)± Standard deviation

A-B means bearing the same superscript within the same row are not significantly different at 5% level (P<0.05)

a-b means bearing the same superscript within the same column are not significantly different at 5% level (P<0.05)

The increases in firmness might be an artifact caused by water loss which results in toughening of epidermis of fleshy tissues rather than retention of flesh firmness (Nunes and Emond 1999). Throughout the study, the temperature of the cool room increased because of the electrical problem in post-harvest laboratory and the produce can not undergo the respiration process normally

4.2 Total color change (Skin color of L*, a* and b* value)

Colorimetric is an instrumental technique that attempts to describe color mathematically in terms of human perception (Hunter and Harold, 1987; Hutchings, 1994; Shewfelt, 1993). Many color scales have been developed, but the most widely used scale is based on the CIE color solid (L*, a* and b*). The L represents lightness where a 0 corresponds to black and 100 correspond to white. Thus, a* value represent redness or greenness in the absence of blue and yellow and b* value represent yellowness or blueness in the absence of red and green. Negative a*value represents more red color than green and positive a* value represents more green color than red. Negative b* represents, more blue color than yellow and positive b* value represents, more yellow color than blue.

Figure 4.2 showed the percent of total color changes and Table 4.2 showing L*, a* and b* values. For L* value in control treatment, decreasing value occurred in day 3 until day 9 and slightly increased in day 12. For 30°C, 40°C and 50°C treatments, it was slightly increased in day 6 and day 9 and finally decreased on day 12 for L* value. From the observation, the lightness of yellow color of sweet corn was turn getting into dark yellow at the end of storage for all treatments. This happen, maybe due to the physiological process that occurred in sweet corn where the sweet corn color getting darker when it over ripen.

Table 4.2: Skin color L*, a* and b* values for MP sweet corns.

TREATMENT	DAY 0	DAY 3	DAY 6	DAY 9	DAY 12
L* value					
CONTROL	75.78 ± 2.03^{Ba}	74.41 ± 1.42^{Bc}	74.02 ± 2.34^{ABa}	71.57 ± 3.38^{Aa}	74.13 ± 3.24^{ABa}
30°C	75.09 ± 3.39^{Ba}	71.49 ± 3.70^{Aab}	72.57 ± 2.59^{ABa}	73.81 ± 2.76^{ABa}	73.24 ± 2.21^{ABa}
40°C	73.76 ± 2.63^{Ba}	70.65 ± 2.69^{Aa}	72.85 ± 2.30^{ABa}	73.78 ± 2.88^{Ba}	72.24 ± 2.88^{ABa}
50°C	75.44 ± 2.09^{Aa}	73.64 ± 2.51^{Abc}	73.81 ± 3.50^{Aa}	74.25 ± 2.30^{Aa}	74.05 ± 2.89^{Aa}
a* value					
CONTROL	2.62 ± 1.21^{Ba}	0.96 ± 1.09^{Aa}	1.11 ± 1.12^{Aab}	1.46 ± 0.59^{Aa}	1.02 ± 0.63^{Aa}
30°C	2.74 ± 0.89^{Ca}	1.47 ± 0.81^{Aa}	1.98 ± 0.72^{ABc}	1.48 ± 0.46^{Aa}	2.25 ± 0.66^{BCb}
40°C	2.70 ± 1.10^{Ba}	0.98 ± 0.32^{Aa}	1.70 ± 0.59^{Abc}	1.63 ± 0.69^{Aab}	1.56 ± 0.98^{Aa}
50°C	2.85 ± 0.85^{Ca}	1.56 ± 0.73^{Ba}	0.46 ± 0.98^{Aa}	1.74 ± 0.82^{Bb}	1.12 ± 1.50^{ABa}
b* value					
CONTROL	45.19 ± 2.13^{Da}	44.92 ± 2.96^{Db}	40.99 ± 4.60^{Ca}	32.96 ± 3.44^{Aa}	36.81 ± 2.77^{Ba}
30°C	46.03 ± 2.13^{Ca}	42.72 ± 4.20^{Bab}	43.40 ± 2.82^{BCa}	36.36 ± 1.85^{Aa}	36.93 ± 3.05^{Ab}
40°C	45.98 ± 2.23^{Ca}	40.97 ± 2.53^{Ba}	43.01 ± 2.29^{Ba}	37.63 ± 2.32^{Aa}	36.61 ± 2.78^{Ab}
50°C	48.34 ± 2.54^{Cb}	42.45 ± 3.29^{Ba}	44.29 ± 3.58^{Bb}	35.20 ± 3.96^{Aa}	36.58 ± 1.40^{Ab}

Note values in table 4.2 are mean of 3 replicate (3 representative sample/replicate)
(Mean n=9)± Standard deviation

A-D means bearing the same superscript within the same row are not significantly different at 5% level ($P<0.05$)

a-c means bearing the same superscript within the same column are not significantly different at 5% level ($P<0.05$)

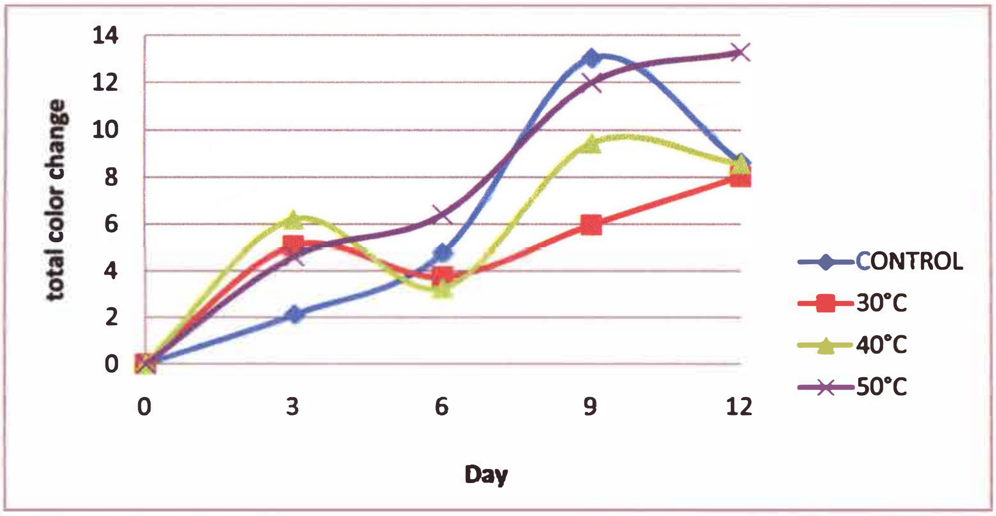


Figure 4.2: Effect of Hot Water Treatment (HWT) on the total color changes value of sweet corn during storage

a* value in control treatment showed a decreasing trend in day 3 and it increased from day 6 until day 9 and finally decreased on day 12. For 30°C treatment, it showed a high increased of a* value on day 12. For 40°C treatment, the a* value decreased starting from day 3 until day 12. Furthermore, for 50°C treatment, a* value decreased in day 6 and increased in day 9. In day 12, treatment 30°C shows different value from others where, there was no much different compare to day 0 (Table 4.2). It is maybe because the chlorophyll pigments in sweet corn less degrade compared to others. b* value in control treatment showed decreasing in day 3 until day 9 and increased in day 12. For treatments 30°C , 40°C and 50°C it is shows the decreasing of b* value in day 3 and day 9 and increased in day 6 (Table 4.2). Based on the results, all treatments still in good yellow color condition (Table 4.2), but from the observation, on day 12, the 50°C treatment showed a brownish color of kernels. This is maybe due to biosynthesis and oxidation of phenolic compounds in sweet corn. Finally, it causes the brown color of kernel skin. Optimum CA environments retard loss of chrophyll (green color), biosynthesis of caratenoids (yellow, orange, and red colors) and anthocyanins (red and blue colors) and produce brown color, where biosynthesis and oxidation of phenolic compounds occurred (Kader, 1986).

4.3 Titratable acidity (% malic acid)

Figure 4.3 and Table 4.3 showed the percentage of malic acid contain in sweet corn. There was significantly different ($P<0.05$) in day 3 until day 12 (Table 4.3). For treatment 50°C, it is shows no significantly different ($P>0.05$) in day 3 until day 9 and finally shows significance in day 12. There was no significance different ($P>0.05$) in 30°C treatments on day 9 and day 12.

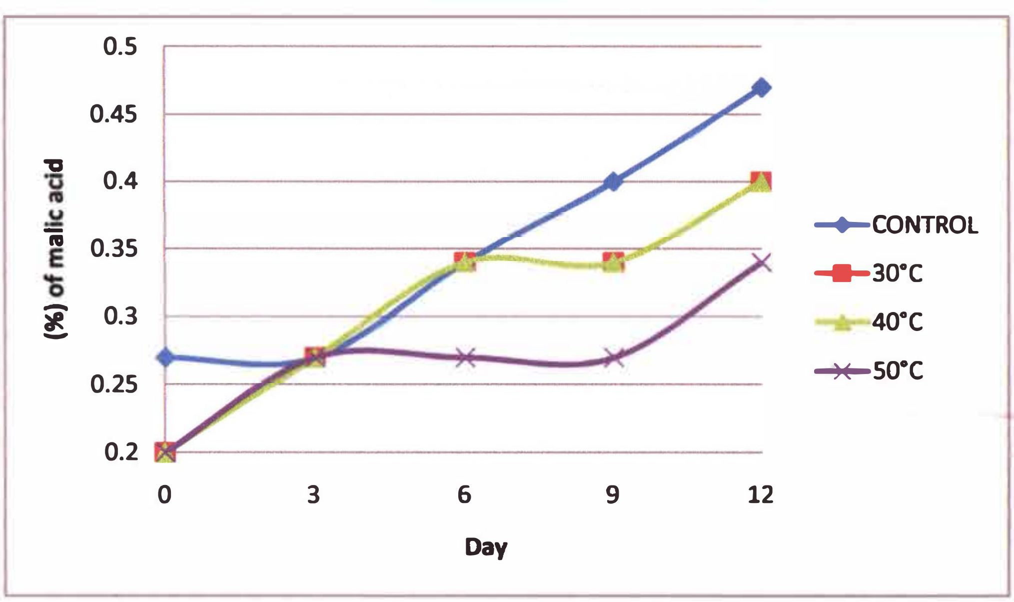


Figure 4.3: Effect of Hot Water Treatment (HWT) on the titratable acidity value of sweet corn during storage

Table 4.3: Titratable acidity values for MP sweet corns.

TREATMENTS	DAY				
	0	3	6	9	12
CONTROL	0.38 ± 0.12^{Aa}	0.41 ± 0.08^{Aa}	0.66 ± 0.07^{Bb}	0.41 ± 0.13^{Aa}	0.52 ± 0.14^{ABa}
30°C	0.26 ± 0.12^{Aa}	0.38 ± 0.12^{ABa}	0.64 ± 0.17^{Cb}	0.54 ± 0.09^{BCa}	0.48 ± 0.11^{BCa}
40°C	0.29 ± 0.04^{Aa}	0.42 ± 0.07^{ABa}	0.50 ± 0.18^{Bab}	0.50 ± 0.16^{Ba}	0.40 ± 0.14^{ABa}
50°C	0.32 ± 0.12^{Aa}	0.43 ± 0.12^{ABa}	0.41 ± 0.12^{ABa}	0.42 ± 0.19^{ABa}	0.53 ± 0.14^{Ba}

Note values in table 4.3 are mean of 3 replicate (3 representative sample/replicate)
(Mean n=9)± Standard deviation

A-C means bearing the same superscript within the same row are not significantly different at 5% level (P<0.05)

a-b means bearing the same superscript within the same column are not significantly different at 5% level (P<0.05)

The increasing value of malic acid shows the level of sourness in sweet corn. The increases of malic acid in sweet corn gave sour in taste and the quality of corn decrease (Paul, 1978). The major components in sweet corn are sucrose, glucose and fructose. Sorbitol and malic acid is secondary components in sweet corn.

4.4 Total Soluble Solid (TSS)

Soluble carbohydrates are often estimated using total soluble (dissolved) solids (TSS) or soluble solids concentration (SSC). Fruit and vegetables that are low in organic acids with little starch at maturity can have as much as 95% TSS as carbohydrates (Chilsom and Picha, 1986a). However, in vegetables containing starch, fructose, or other storage carbohydrate, or having TSS <5%, TSS does not adequately represent total sugars or sweetness (McCombs *et al.,* 1976). Figure 4.4 and Table 4.4 showed the graph and the data for total soluble solid in sweet corn. After Hot Water Treatment (HWT), the results showed significantly different ($P<0.05$) in day 0 for all treatments. There was significantly different ($P<0.05$) in day 3 until day 12. For treatments 40°C, it is showed no significantly different ($P>0.05$) in day 3 and day 6 (Table 4.4). In day 9 and day 12, it showed no significantly different ($P>0.05$) for control and 50°C treatment.

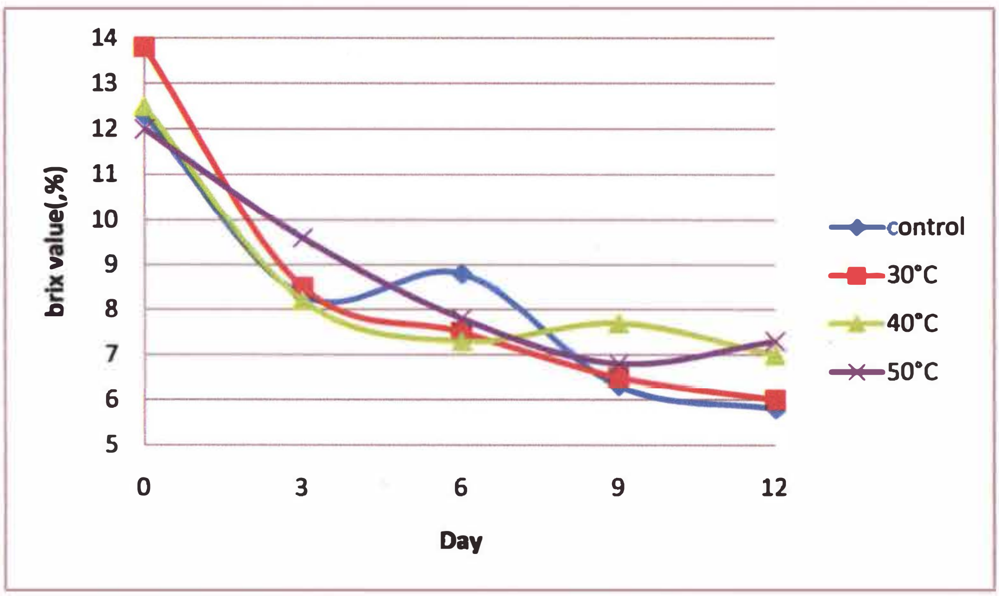


Figure 4.4: Effect of Hot Water Treatment (HWT) on the total soluble solid value of sweet corn during storage

Table 4.4: Total Soluble Solid values for MP sweet corns.

TREATMENTS	DAY				
	0	3	6	9	12
CONTROL	12.33±0.82^{Ca}	8.83±0.75^{Bbc}	8.33±1.75^{Ba}	5.83±0.75^{Aa}	6.33±1.03^{Aa}
30°C	13.83±0.75^{Cb}	7.50±1.22^{ABab}	7.17±0.41^{ABa}	8.50±0.84^{Bb}	6.50±0.55^{Aab}
40°C	12.50±1.05^{Bab}	7.00±0.89^{Aa}	8.17±1.47^{Aa}	7.33±2.07^{Aab}	7.50±0.55^{AC}
50°C	12.00±0.63^{Ca}	9.67±1.21^{BC}	7.83±2.82^{Aa}	6.83±0.41^{Aab}	7.300.52^{Aab}

Note values in table 4.4 are mean of 3 replicate (3 representative sample/replicate)
(Mean n=9)± Standard deviation

A-C means bearing the same superscript within the same row are not significantly different at 5% level (P<0.05)

a-c means bearing the same superscript within the same column are not significantly different at 5% level (P<0.05)

The sugar content is very important in determine the quality of sweet corn and the rapid decreases due to ordinary temperatures. The decreases can be overcome if the corn is kept at 0°C. The losses of sugar are about four times as rapid at 10°C as at 0°C (Appleman and Arthur, 1919). Furthermore, starch is the predominant carbohydrates component of sweet corn. As sweet corn matures, there is a decline in the starch content. Sweet corn at highest edible quality in the milk stage. Sugar content decreases and the starch content increases as sweet corn passes from this stage. Ripening of sweet corn makes the sugar to decrease. For sweet corn, the sucrose is synthesis by sucrose phosphate synthase (SPS) (Huber and Huber, 1992). Sucrose phosphate synthase is found in the cytosol and converts UDP- glucose and fructose-6-phosphate to sucrose. SPS may be the dominant enzyme in plants in which sucrose or hexoses, rather than starch, are accumulated as the end product of carbohydrates accumulation (Hawker, 1985). TSS level decreasing through storage period, however it is contradicted with the malic acid level which is increasing over storage day. Therefore, the quality of sweet corn became sour according to malic acid increases.

4.5 Weight Loss analysis

Figure 4.5 and table 4.5 showed percentage of weight loss analyses graph and data for sweet corn. In control treatment, there was no significantly different (P>0.05) in day 0 until day 12 but for others treatments, it showed significance (P<0.05) (Table 4.5).

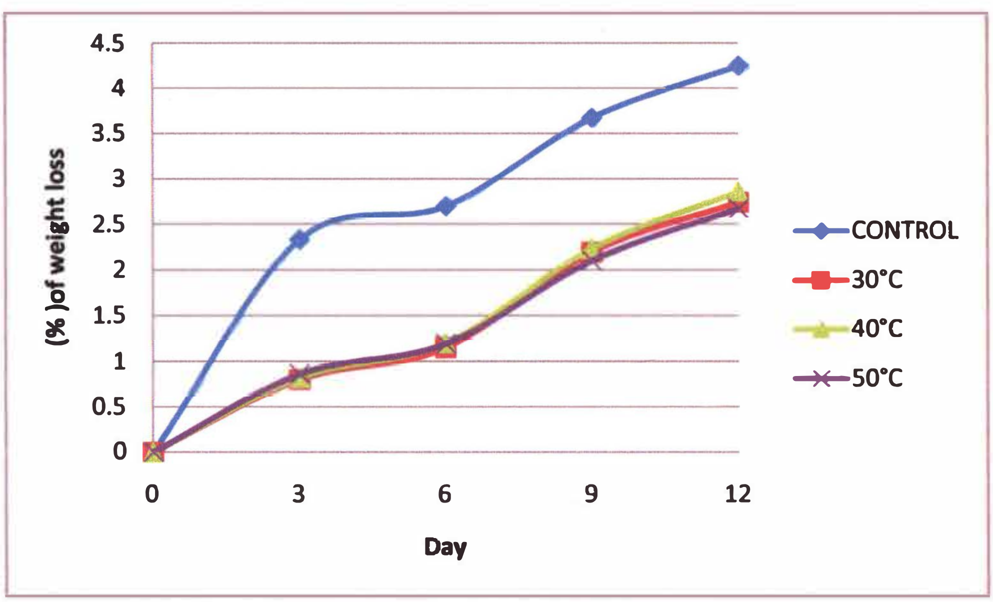


Figure 4.5: Effect of Hot Water Treatment (HWT) on the weight loss value of sweet corn during storage

Table 4.5: weight loss values for MP sweet corns.

TREATMENTS	DAY				
	0	**3**	**6**	**9**	**12**
CONTROL	$0.00±0.00^{Aa}$	$2.42±2.95^{Aa}$	$2.75±2.95^{Aa}$	$3.69±3.00^{Aa}$	$4.27±3.01^{Aa}$
30°C	$0.00±0.00^{Aa}$	$0.76±0.04^{Ba}$	$1.11±0.06^{Ca}$	$2.16±0.09^{Da}$	$2.74±0.06^{Ea}$
40°C	$0.00±0.00^{Aa}$	$0.83±0.01^{Ba}$	$1.21±0.07^{Ca}$	$2.24±0.12^{Da}$	$2.87±0.14^{Ea}$
50°C	$0.00±0.00^{Aa}$	$0.84±0.08^{Ba}$	$1.17±0.10^{Ca}$	$2.07±0.12^{Da}$	$2.63±0.07^{Ea}$

Note values in table 4.5 are mean of 3 replicate (3 representative sample/replicate) (Mean n=9)± Standard deviation

A-E means bearing the same superscript within the same row are not significantly different at 5% level (P<0.05)

a means bearing the same superscript within the same column are not significantly different at 5% level (P<0.05)

The occurrence of water loss maybe occurred because of surface area per volume of the sweet corn. Sweet corn contain kernel which are small and higher in respiration rate which results in a high rate of heat evolution. Mechanical damage also can accelerate the water loss from the produce (Wells, 1962). Bruising damages on the produce surface and tissue allowed much greater flow of gaseous material through the damaged area. Furthermore, for sweet corn the precooling steps are very important. It is because, when the sweet corns are picked out from the plant, so the corns are breaking from getting nutrient and others metabolism system. In this stage, the sweet corn in 'stress' condition and it will changes the corn respiration where the rate of respiration become faster than before.

Sweet corn can be precooled adequately by vacuum cooling to minimize water loss from the husks and kernels (Showalter, 1957; Stewart and Barger, 1960).

Hydrocooling by spraying, showering, or immersion in water at 0-3°C is effective to reduce the heat in sweet corn (Talbot *et al.*, 1989; 1991)

CHAPTER 5

CONCLUSIONS

5.1 Conclusions

Four types of HWT treatment were performed T1: control, T2: 30°C, T3: 40°C and T4: 50°C on sweet corns and stored at 5 ± 1°C for 12 days. Throughout the study, physical, chemical and statistical analyses were done to determine the quality of sweet corn. The results showed, there was no significant different ($P>0.05$) for all treatments in texture (firmness), color changes, Total Soluble Solid (TSS), Titratable Acidity (TA) but there was significantly different ($P<0.05$) for weight loss. Control treatment shows highest water losses compare to others treatment. It meant, hot water treatment prevent the water losses and can be applied for hybrid sweet corn (926).

5.2 Suggestion for future studies

This study only analysed the basic parameters such as texture, titratable acidity, total soluble solid, percentage of weight loss and total color changes. For the further study, the analyses must be done in pH condition, microbial analyses and others, in order to analyze more hybrid sweet corn composition and microbial infections. Furthermore, from observation it is shows that hybrid sweet corn very significantly different in weight loss values where control treatment shows higher value. But, for others analyses, it shows slightly variable and no significant ($P>0.05$) between these four treatments. It shows that, Hot Water Treatment only shows the effect in controlling the water loss form produce but for others analyses it do not shows much changes. For further study, it should be treatments such as edible coating (such as pectin, carrageenan, chitosan), ozone (O_3) or milk whey in analyzed this hybrid sweet corn.

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APPENDICES

APPENDICES A (1) descriptive statistics for firmness value in day 0

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	33.9567*	11.94809	.031	2.3195	65.5939
	2	27.6608	11.94809	.107	-3.9764	59.2980
	3	17.6407	11.94809	.458	-13.9965	49.2779
30°C	1	-33.9567*	11.94809	.031	-65.5939	-2.3195
	2	-6.2959	11.94809	.952	-37.9331	25.3413
	3	-16.3160	11.94809	.526	-47.9532	15.3212
40°C	1	-27.6608	11.94809	.107	-59.2980	3.9764
	2	6.2959	11.94809	.952	-25.3413	37.9331
	3	-10.0201	11.94809	.836	-41.6573	21.6171
50°C	1	-17.6407	11.94809	.458	-49.2779	13.9965
	2	16.3160	11.94809	.526	-15.3212	47.9532
	3	10.0201	11.94809	.836	-21.6171	41.6573

Based on observed means.

The error term is Mean Square (Error) =1070.676.

The mean difference is significant at the .05 level.

APPENDICES A (2) descriptive statistics for firmness value in day 3

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	8.0381	10.20515	.860	-18.9840	35.0602
	2	4.9873	10.20515	.961	-22.0348	32.0094
	3	25.8145	10.20515	.066	-1.2076	52.8366
30°C	1	-8.0381	10.20515	.860	-35.0602	18.9840
	2	-3.0508	10.20515	.991	-30.0729	23.9713
	3	17.7764	10.20515	.312	-9.2457	44.7985
40°C	1	-4.9873	10.20515	.961	-32.0094	22.0348
	2	3.0508	10.20515	.991	-23.9713	30.0729
	3	20.8272	10.20515	.186	-6.1949	47.8493
50°C	1	-25.8145	10.20515	.066	-52.8366	1.2076
	2	-17.7764	10.20515	.312	-44.7985	9.2457
	3	-20.8272	10.20515	.186	-47.8493	6.1949

Based on observed means.

The error term is Mean Square (Error) = 781.088.

APPENDICES A (3) descriptive statistics for firmness value in day 6

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	2.0519	6.88194	.991	-16.1707	20.2745
	2	3.2862	6.88194	.964	-14.9364	21.5088
	3	11.7563	6.88194	.329	-6.4663	29.9789
30°C	1	-2.0519	6.88194	.991	-20.2745	16.1707
	2	1.2343	6.88194	.998	-16.9883	19.4569
	3	9.7044	6.88194	.498	-8.5182	27.9270
40°C	1	-3.2862	6.88194	.964	-21.5088	14.9364
	2	-1.2343	6.88194	.998	-19.4569	16.9883
	3	8.4701	6.88194	.610	-9.7525	26.6927
50°C	1	-11.7563	6.88194	.329	-29.9789	6.4663
	2	-9.7044	6.88194	.498	-27.9270	8.5182
	3	-8.4701	6.88194	.610	-26.6927	9.7525

Based on observed means.

The error term is Mean Square (Error) = 355.208.

APPENDICES A (4) descriptive statistics for firmness value in day 9

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONT RL	1	16.2015	9.18228	.301	-8.1122	40.5151
	2	23.0433	9.18228	.069	-1.2704	47.3569
	3	20.6927	9.18228	.122	-3.6209	45.0064
30°C	1	-16.2015	9.18228	.301	-40.5151	8.1122
	2	6.8418	9.18228	.878	-17.4718	31.1554
	3	4.4913	9.18228	.961	-19.8224	28.8049
40°C	1	-23.0433	9.18228	.069	-47.3569	1.2704
	2	-6.8418	9.18228	.878	-31.1554	17.4718
	3	-2.3505	9.18228	.994	-26.6642	21.9631
50°C	1	-20.6927	9.18228	.122	-45.0064	3.6209
	2	-4.4913	9.18228	.961	-28.8049	19.8224
	3	2.3505	9.18228	.994	-21.9631	26.6642

Based on observed means.

The error term is Mean Square (Error) = 632.357.

APPENDICES A (5) descriptive statistics for firmness value in day 12

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	10.7915	8.59790	.595	-11.9748	33.5577
	2	14.4795	8.59790	.342	-8.2867	37.2458
	3	18.4953	8.59790	.150	-4.2710	41.2615
30°C	1	-10.7915	8.59790	.595	-33.5577	11.9748
	2	3.6881	8.59790	.973	-19.0782	26.4543
	3	7.7038	8.59790	.807	-15.0625	30.4701
40°C	1	-14.4795	8.59790	.342	-37.2458	8.2867
	2	-3.6881	8.59790	.973	-26.4543	19.0782
	3	4.0157	8.59790	.966	-18.7505	26.7820
50°C	1	-18.4953	8.59790	.150	-41.2615	4.2710
	2	-7.7038	8.59790	.807	-30.4701	15.0625
	3	-4.0157	8.59790	.966	-26.7820	18.7505

Based on observed means.

The error term is Mean Square (Error) = 554.429.

APPENDICES B (1) descriptive statistics for L* value in day 0

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	.6893	.94765	.886	-1.8199	3.1986
	2	2.0227	.94765	.155	-.4866	4.5319
	3	.3367	.94765	.984	-2.1726	2.8459
30°C	1	-.6893	.94765	.886	-3.1986	1.8199
	2	1.3333	.94765	.500	-1.1759	3.8426
	3	-.3527	.94765	.982	-2.8619	2.1566
40°C	1	-2.0227	.94765	.155	-4.5319	.4866
	2	-1.3333	.94765	.500	-3.8426	1.1759
	3	-1.6860	.94765	.294	-4.1953	.8233
50°C	1	-.3367	.94765	.984	-2.8459	2.1726
	2	.3527	.94765	.982	-2.1566	2.8619
	3	1.6860	.94765	.294	-.8233	4.1953

Based on observed means.
The error term is Mean Square (Error) = 6.735.

APPENDICES B (2) descriptive statistics for L* value in day 3

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	2.9207*	.98713	.023	.3068	5.5345
	2	3.7667*	.98713	.002	1.1528	6.3805
	3	.7753	.98713	.861	-1.8385	3.3892
30°C	1	-2.9207*	.98713	.023	-5.5345	-.3068
	2	.8460	.98713	.827	-1.7678	3.4598
	3	-2.1453	.98713	.143	-4.7592	.4685
40°C	1	-3.7667*	.98713	.002	-6.3805	-1.1528
	2	-.8460	.98713	.827	-3.4598	1.7678
	3	-2.9913*	.98713	.019	-5.6052	-.3775
50°C	1	-.7753	.98713	.861	-3.3892	1.8385
	2	2.1453	.98713	.143	-.4685	4.7592
	3	2.9913*	.98713	.019	.3775	5.6052

Based on observed means.

The error term is Mean Square (Error) = 7.308.

*. The mean difference is significant at the .05 level.

APPENDICES B (3) descriptive statistics for L* value in day 6

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONT RL	1	1.4580	.99630	.466	-1.1801	4.0961
	2	1.1713	.99630	.645	-1.4668	3.8094
	3	.2133	.99630	.996	-2.4248	2.8514
30°C	1	-1.4580	.99630	.466	-4.0961	1.1801
	2	-.2867	.99630	.992	-2.9248	2.3514
	3	-1.2447	.99630	.599	-3.8828	1.3934
40°C	1	-1.1713	.99630	.645	-3.8094	1.4668
	2	.2867	.99630	.992	-2.3514	2.9248
	3	-.9580	.99630	.772	-3.5961	1.6801
50°C	1	-.2133	.99630	.996	-2.8514	2.4248
	2	1.2447	.99630	.599	-1.3934	3.8828
	3	.9580	.99630	.772	-1.6801	3.5961

Based on observed means.

The error term is Mean Square (Error) = 7.445.

PPENDICES B (4) descriptive statistics for L* value in day 9

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-2.2440	1.04356	.150	-5.0072	.5192
	2	-2.2133	1.04356	.159	-4.9766	.5499
	3	-2.6820	1.04356	.060	-5.4452	.0812
30°C	1	2.2440	1.04356	.150	-.5192	5.0072
	2	.0307	1.04356	1.000	-2.7326	2.7939
	3	-.4380	1.04356	.975	-3.2012	2.3252
40°C	1	2.2133	1.04356	.159	-.5499	4.9766
	2	-.0307	1.04356	1.000	-2.7939	2.7326
	3	-.4687	1.04356	.970	-3.2319	2.2946
50°C	1	2.6820	1.04356	.060	-.0812	5.4452
	2	.4380	1.04356	.975	-2.3252	3.2012
	3	.4687	1.04356	.970	-2.2946	3.2319

Based on observed means.

The error term is Mean Square (Error) = 8.168.

APPENDICES B (5) descriptive statistics for L* value in day 12

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	.8927	1.03424	.824	-1.8459	3.6312
	2	1.8927	1.03424	.270	-.8459	4.6312
	3	.0827	1.03424	1.000	-2.6559	2.8212
30°C	1	-.8927	1.03424	.824	-3.6312	1.8459
	2	1.0000	1.03424	.769	-1.7385	3.7385
	3	-.8100	1.03424	.862	-3.5485	1.9285
40°C	1	-1.8927	1.03424	.270	-4.6312	.8459
	2	-1.0000	1.03424	.769	-3.7385	1.7385
	3	-1.8100	1.03424	.308	-4.5485	.9285
50°C	1	-.0827	1.03424	1.000	-2.8212	2.6559
	2	.8100	1.03424	.862	-1.9285	3.5485
	3	1.8100	1.03424	.308	-.9285	4.5485

Based on observed means.

The error term is Mean Square (Error) = 8.022.

APPENDICES C (1) descriptive statistics for a* value in day 0

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-.1160	.37471	.990	-1.1082	.8762
	2	-.0767	.37471	.997	-1.0689	.9155
	3	-.2260	.37471	.931	-1.2182	.7662
30°C	1	.1160	.37471	.990	-.8762	1.1082
	2	.0393	.37471	1.000	-.9529	1.0315
	3	-.1100	.37471	.991	-1.1022	.8822
40°C	1	.0767	.37471	.997	-.9155	1.0689
	2	-.0393	.37471	1.000	-1.0315	.9529
	3	-.1493	.37471	.978	-1.1415	.8429
50°C	1	.2260	.37471	.931	-.7662	1.2182
	2	.1100	.37471	.991	-.8822	1.1022
	3	.1493	.37471	.978	-.8429	1.1415

Based on observed means.

The error term is Mean Square (Error) = 1.053.

APPENDICES C (2) descriptive statistics for a* value in day 3

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONT RL	1	-.5087	.28735	.298	-1.2695	.2522
	2	-.0127	.28735	1.000	-.7735	.7482
	3	-.5987	.28735	.171	-1.3595	.1622
30°C	1	.5087	.28735	.298	-.2522	1.2695
	2	.4960	.28735	.320	-.2649	1.2569
	3	-.0900	.28735	.989	-.8509	.6709
40°C	1	.0127	.28735	1.000	-.7482	.7735
	2	-.4960	.28735	.320	-1.2569	.2649
	3	-.5860	.28735	.186	-1.3469	.1749
50°C	1	.5987	.28735	.171	-.1622	1.3595
	2	.0900	.28735	.989	-.6709	.8509
	3	.5860	.28735	.186	-.1749	1.3469

Based on observed means.

The error term is Mean Square (Error) = .619.

APPENDICES C (3) descriptive statistics for a* value in day 6

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	-.8620*	.31824	.043	-1.7047	-.0193
	2	-.5873	.31824	.263	-1.4300	.2553
	3	.6500	.31824	.185	-.1927	1.4927
30°C	1	.8620*	.31824	.043	.0193	1.7047
	2	.2747	.31824	.824	-.5680	1.1173
	3	1.5120*	.31824	.000	.6693	2.3547
40°C	1	.5873	.31824	.263	-.2553	1.4300
	2	-.2747	.31824	.824	-1.1173	.5680
	3	1.2373*	.31824	.002	.3947	2.0800
50°C	1	-.6500	.31824	.185	-1.4927	.1927
	2	-1.5120*	.31824	.000	-2.3547	-.6693
	3	-1.2373*	.31824	.002	-2.0800	-.3947

Based on observed means.

The error term is Mean Square (Error) = .760.

*. The mean difference is significant at the .05 level.

PPENDICES C (4) descriptive statistics for a* value in day 9

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-1.2353*	.25894	.000	-1.9210	-.5497
	2	-.6133	.25894	.095	-1.2990	.0723
	3	-.7207*	.25894	.036	-1.4063	-.0350
30°C	1	1.2353*	.25894	.000	.5497	1.9210
	2	.6220	.25894	.088	-.0636	1.3076
	3	.5147	.25894	.205	-.1710	1.2003
40°C	1	.6133	.25894	.095	-.0723	1.2990
	2	-.6220	.25894	.088	-1.3076	.0636
	3	-.1073	.25894	.976	-.7930	.5783
50°C	1	.7207*	.25894	.036	.0350	1.4063
	2	-.5147	.25894	.205	-1.2003	.1710
	3	.1073	.25894	.976	-.5783	.7930

Based on observed means.

The error term is Mean Square (Error) = .503.

*. The mean difference is significant at the .05 level.

APPENDICES C (5) descriptive statistics for a* value in day 12

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-.0153	.35414	1.000	-.9531	.9224
	2	-.0973	.35414	.993	-1.0351	.8404
	3	.3453	.35414	.764	-.5924	1.2831
30°C	1	.0153	.35414	1.000	-.9224	.9531
	2	-.0820	.35414	.996	-1.0197	.8557
	3	.3607	.35414	.739	-.5771	1.2984
40°C	1	.0973	.35414	.993	-.8404	1.0351
	2	.0820	.35414	.996	-.8557	1.0197
	3	.4427	.35414	.598	-.4951	1.3804
50°C	1	-.3453	.35414	.764	-1.2831	.5924
	2	-.3607	.35414	.739	-1.2984	.5771
	3	-.4427	.35414	.598	-1.3804	.4951

Based on observed means.

The error term is Mean Square (Error) = .941.

APPENDICES D (1) descriptive statistics for b* value in day 0

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-.8367	.82704	.743	-3.0266	1.3532
	2	-.7940	.82704	.772	-2.9839	1.3959
	3	-3.1547*	.82704	.002	-5.3446	-.9648
30°C	1	.8367	.82704	.743	-1.3532	3.0266
	2	.0427	.82704	1.000	-2.1472	2.2326
	3	-2.3180*	.82704	.034	-4.5079	-.1281
40°C	1	.7940	.82704	.772	-1.3959	2.9839
	2	-.0427	.82704	1.000	-2.2326	2.1472
	3	-2.3607*	.82704	.030	-4.5506	-.1708
50°C	1	3.1547*	.82704	.002	.9648	5.3446
	2	2.3180*	.82704	.034	.1281	4.5079
	3	2.3607*	.82704	.030	.1708	4.5506

Based on observed means.

The error term is Mean Square (Error) = 5.130.

*. The mean difference is significant at the .05 level.

APPENDICES D (2) descriptive statistics for b* value in day 3

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	2.2000	1.23281	.291	-1.0644	5.4644
	2	3.9507*	1.23281	.012	.6863	7.2150
	3	.6293	1.23281	.956	-2.6350	3.8937
30°C	1	-2.2000	1.23281	.291	-5.4644	1.0644
	2	1.7507	1.23281	.492	-1.5137	5.0150
	3	-1.5707	1.23281	.583	-4.8350	1.6937
40°C	1	-3.9507*	1.23281	.012	-7.2150	-.6863
	2	-1.7507	1.23281	.492	-5.0150	1.5137
	3	-3.3213*	1.23281	.045	-6.5857	-.0570
50°C	1	-.6293	1.23281	.956	-3.8937	2.6350
	2	1.5707	1.23281	.583	-1.6937	4.8350
	3	3.3213*	1.23281	.045	.0570	6.5857

Based on observed means.

The error term is Mean Square (Error) = 11.399.

*. The mean difference is significant at the .05 level.

APPENDICES D (3) descriptive statistics for b* value in day 6

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-2.4167	1.22840	.213	-5.6693	.8360
	2	-2.0273	1.22840	.359	-5.2800	1.2253
	3	-1.4667	1.22840	.633	-4.7193	1.7860
30°C	1	2.4167	1.22840	.213	-.8360	5.6693
	2	.3893	1.22840	.989	-2.8633	3.6420
	3	.9500	1.22840	.866	-2.3027	4.2027
40°C	1	2.0273	1.22840	.359	-1.2253	5.2800
	2	-.3893	1.22840	.989	-3.6420	2.8633
	3	.5607	1.22840	.968	-2.6920	3.8133
50°C	1	1.4667	1.22840	.633	-1.7860	4.7193
	2	-.9500	1.22840	.866	-4.2027	2.3027
	3	-.5607	1.22840	.968	-3.8133	2.6920

Based on observed means.

The error term is Mean Square (Error) = 11.317.

APPENDICES D (4) descriptive statistics for b* value in day 9

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-3.9693*	1.01387	.001	-6.6540	-1.2847
	2	-3.6520*	1.01387	.004	-6.3366	-.9674
	3	-3.6260*	1.01387	.004	-6.3106	-.9414
30°C	1	3.9693*	1.01387	.001	1.2847	6.6540
	2	.3173	1.01387	.989	-2.3673	3.0020
	3	.3433	1.01387	.986	-2.3413	3.0280
40°C	1	3.6520*	1.01387	.004	.9674	6.3366
	2	-.3173	1.01387	.989	-3.0020	2.3673
	3	.0260	1.01387	1.000	-2.6586	2.7106
50°C	1	3.6260*	1.01387	.004	.9414	6.3106
	2	-.3433	1.01387	.986	-3.0280	2.3413
	3	-.0260	1.01387	1.000	-2.7106	2.6586

Based on observed means.

The error term is Mean Square (Error) = 7.710.

*. The mean difference is significant at the .05 level.

APPENDICES D (5) descriptive statistics for b* value in day 12

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	.4440	1.03549	.973	-2.2979	3.1859
	2	-.8267	1.03549	.855	-3.5685	1.9152
	3	1.6120	1.03549	.411	-1.1299	4.3539
30°C	1	-.4440	1.03549	.973	-3.1859	2.2979
	2	-1.2707	1.03549	.612	-4.0125	1.4712
	3	1.1680	1.03549	.674	-1.5739	3.9099
40°C	1	.8267	1.03549	.855	-1.9152	3.5685
	2	1.2707	1.03549	.612	-1.4712	4.0125
	3	2.4387	1.03549	.098	-.3032	5.1805
50°C	1	-1.6120	1.03549	.411	-4.3539	1.1299
	2	-1.1680	1.03549	.674	-3.9099	1.5739
	3	-2.4387	1.03549	.098	-5.1805	.3032

Based on observed means.

The error term is Mean Square (Error) = 8.042.

APPENDICES E (1) descriptive statistics for Titratable Acidity day 0

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	.1222	.05415	.130	-.0245	.2689
	2	.0889	.05415	.371	-.0578	.2356
	3	.0556	.05415	.736	-.0912	.2023
30°C	1	-.1222	.05415	.130	-.2689	.0245
	2	-.0333	.05415	.926	-.1800	.1134
	3	-.0667	.05415	.612	-.2134	.0800
40°C	1	-.0889	.05415	.371	-.2356	.0578
	2	.0333	.05415	.926	-.1134	.1800
	3	-.0333	.05415	.926	-.1800	.1134
50°C	1	-.0556	.05415	.736	-.2023	.0912
	2	.0667	.05415	.612	-.0800	.2134
	3	.0333	.05415	.926	-.1134	.1800

Based on observed means.

The error term is Mean Square (Error) = .013.

APPENDICES E (2) descriptive statistics for Titratable Acidity day 3

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
CONTRL	1	.0333	.04714	.894	-.0944	.1611
	2	-.0111	.04714	.995	-.1388	.1166
	3	-.0222	.04714	.965	-.1499	.1055
30°C	1	-.0333	.04714	.894	-.1611	.0944
	2	-.0444	.04714	.782	-.1722	.0833
	3	-.0556	.04714	.644	-.1833	.0722
40°C	1	.0111	.04714	.995	-.1166	.1388
	2	.0444	.04714	.782	-.0833	.1722
	3	-.0111	.04714	.995	-.1388	.1166
50°C	1	.0222	.04714	.965	-.1055	.1499
	2	.0556	.04714	.644	-.0722	.1833
	3	.0111	.04714	.995	-.1166	.1388

Based on observed means.

The error term is Mean Square (Error) = .010.

APPENDICES E (3) descriptive statistics for Titratable Acidity day 6

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	.0111	.06632	.998	-.1686	.1908
	2	.1556	.06632	.109	-.0241	.3352
	3	.2444*	.06632	.004	.0648	.4241
30°C	1	-.0111	.06632	.998	-.1908	.1686
	2	.1444	.06632	.151	-.0352	.3241
	3	.2333*	.06632	.007	.0537	.4130
40°C	1	-.1556	.06632	.109	-.3352	.0241
	2	-.1444	.06632	.151	-.3241	.0352
	3	.0889	.06632	.545	-.0908	.2686
50°C	1	-.2444*	.06632	.004	-.4241	-.0648
	2	-.2333*	.06632	.007	-.4130	-.0537
	3	-.0889	.06632	.545	-.2686	.0908

Based on observed means.

The error term is Mean Square (Error) = .020.

*. The mean difference is significant at the .05 level.

APPENDICES E (4) descriptive statistics for Titratable Acidity day 9

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-.1333	.06804	.224	-.3177	.0510
	2	-.0889	.06804	.566	-.2732	.0955
	3	-.0111	.06804	.998	-.1955	.1732
30°C	1	.1333	.06804	.224	-.0510	.3177
	2	.0444	.06804	.914	-.1399	.2288
	3	.1222	.06804	.294	-.0621	.3066
40°C	1	.0889	.06804	.566	-.0955	.2732
	2	-.0444	.06804	.914	-.2288	.1399
	3	.0778	.06804	.666	-.1066	.2621
50°C	1	.0111	.06804	.998	-.1732	.1955
	2	-.1222	.06804	.294	-.3066	.0621
	3	-.0778	.06804	.666	-.2621	.1066

Based on observed means.

The error term is Mean Square (Error) = .021.

APPENDICES E (5) descriptive statistics for Titratable Acidity day 12

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	.0444	.06298	.894	-.1262	.2151
	2	.1222	.06298	.232	-.0484	.2928
	3	-.0111	.06298	.998	-.1817	.1595
30°C	1	-.0444	.06298	.894	-.2151	.1262
	2	.0778	.06298	.610	-.0928	.2484
	3	-.0556	.06298	.814	-.2262	.1151
40°C	1	-.1222	.06298	.232	-.2928	.0484
	2	-.0778	.06298	.610	-.2484	.0928
	3	-.1333	.06298	.169	-.3040	.0373
50°C	1	.0111	.06298	.998	-.1595	.1817
	2	.0556	.06298	.814	-.1151	.2262
	3	.1333	.06298	.169	-.0373	.3040

Based on observed means.

The error term is Mean Square (Error) = .018.

APPENDICES F (1) descriptive statistics for total soluble solid day 0

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-1.5000*	.47726	.024	-2.8358	-.1642
	2	-.1667	.47726	.985	-1.5025	1.1692
	3	.3333	.47726	.896	-1.0025	1.6692
30°C	1	1.5000*	.47726	.024	.1642	2.8358
	2	1.3333	.47726	.051	-.0025	2.6692
	3	1.8333*	.47726	.005	.4975	3.1692
40°C	1	.1667	.47726	.985	-1.1692	1.5025
	2	-1.3333	.47726	.051	-2.6692	.0025
	3	.5000	.47726	.724	-.8358	1.8358
50°C	1	-.3333	.47726	.896	-1.6692	1.0025
	2	-1.8333*	.47726	.005	-3.1692	-.4975
	3	-.5000	.47726	.724	-1.8358	.8358

Based on observed means.

The error term is Mean Square (Error) = .683.

*. The mean difference is significant at the .05 level.

APPENDICES F (2) descriptive statistics for total soluble solid day 3

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
CONTRL	1	1.3333	.60093	.152	-.3486	3.0153
	2	1.8333*	.60093	.030	.1514	3.5153
	3	-.8333	.60093	.522	-2.5153	.8486
30°C	1	-1.3333	.60093	.152	-3.0153	.3486
	2	.5000	.60093	.839	-1.1820	2.1820
	3	-2.1667*	.60093	.009	-3.8486	-.4847
40°C	1	-1.8333*	.60093	.030	-3.5153	-.1514
	2	-.5000	.60093	.839	-2.1820	1.1820
	3	-2.6667*	.60093	.001	-4.3486	-.9847
50°C	1	.8333	.60093	.522	-.8486	2.5153
	2	2.1667*	.60093	.009	.4847	3.8486
	3	2.6667*	.60093	.001	.9847	4.3486

Based on observed means.

The error term is Mean Square (Error) = 1.083.

*. The mean difference is significant at the .05 level.

PPENDICES F (3) descriptive statistics for total soluble solid day 6

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONT RL	1	1.1667	.75093	.426	-.9351	3.2685
	2	.1667	.75093	.996	-1.9351	2.2685
	3	.5000	.75093	.909	-1.6018	2.6018
30°C	1	-1.1667	.75093	.426	-3.2685	.9351
	2	-1.0000	.75093	.554	-3.1018	1.1018
	3	-.6667	.75093	.811	-2.7685	1.4351
40°C	1	-.1667	.75093	.996	-2.2685	1.9351
	2	1.0000	.75093	.554	-1.1018	3.1018
	3	.3333	.75093	.970	-1.7685	2.4351
50°C	1	-.5000	.75093	.909	-2.6018	1.6018
	2	.6667	.75093	.811	-1.4351	2.7685
	3	-.3333	.75093	.970	-2.4351	1.7685

Based on observed means.

The error term is Mean Square (Error) = 1.692.

APPENDICES F (4) descriptive statistics for total soluble solid day 9

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONT RL	1	-2.6667*	.68920	.005	-4.5957	-.7376
	2	-1.5000	.68920	.164	-3.4290	.4290
	3	-1.0000	.68920	.484	-2.9290	.9290
30°C	1	2.6667*	.68920	.005	.7376	4.5957
	2	1.1667	.68920	.353	-.7624	3.0957
	3	1.6667	.68920	.106	-.2624	3.5957
40°C	1	1.5000	.68920	.164	-.4290	3.4290
	2	-1.1667	.68920	.353	-3.0957	.7624
	3	.5000	.68920	.886	-1.4290	2.4290
50°C	1	1.0000	.68920	.484	-.9290	2.9290
	2	-1.6667	.68920	.106	-3.5957	.2624
	3	-.5000	.68920	.886	-2.4290	1.4290

Based on observed means.

The error term is Mean Square (Error) = 1.425.

*. The mean difference is significant at the .05 level.

APPENDICES F (5) descriptive statistics for total soluble solid day 12

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	-.1667	.40139	.975	-1.2901	.9568
	2	-1.1667*	.40139	.040	-2.2901	-.0432
	3	-1.0000	.40139	.092	-2.1235	.1235
30°C	1	.1667	.40139	.975	-.9568	1.2901
	2	-1.0000	.40139	.092	-2.1235	.1235
	3	-.8333	.40139	.195	-1.9568	.2901
40°C	1	1.1667*	.40139	.040	.0432	2.2901
	2	1.0000	.40139	.092	-.1235	2.1235
	3	.1667	.40139	.975	-.9568	1.2901
50°C	1	1.0000	.40139	.092	-.1235	2.1235
	2	.8333	.40139	.195	-.2901	1.9568
	3	-.1667	.40139	.975	-1.2901	.9568

Based on observed means.
The error term is Mean Square (Error) = .483.

*. The mean difference is significant at the .05 level.

APPENDICES G (1) descriptive statistics for weight loss day 3

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	1.6533	1.20385	.547	-2.2018	5.5085
	2	1.5833	1.20385	.579	-2.2718	5.4385
	3	1.5733	1.20385	.584	-2.2818	5.4285
30°C	1	-1.6533	1.20385	.547	-5.5085	2.2018
	2	-.0700	1.20385	1.000	-3.9252	3.7852
	3	-.0800	1.20385	1.000	-3.9352	3.7752
40°C	1	-1.5833	1.20385	.579	-5.4385	2.2718
	2	.0700	1.20385	1.000	-3.7852	3.9252
	3	-.0100	1.20385	1.000	-3.8652	3.8452
50°C	1	-1.5733	1.20385	.584	-5.4285	2.2818
	2	.0800	1.20385	1.000	-3.7752	3.9352
	3	.0100	1.20385	1.000	-3.8452	3.8652

Based on observed means.

The error term is Mean Square (Error) = 2.174.

APPENDICES G (2) descriptive statistics for weight loss day 6

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONT RL	1	1.6433	1.20575	.553	-2.2179	5.5046
	2	1.5467	1.20575	.597	-2.3146	5.4079
	3	1.5833	1.20575	.580	-2.2779	5.4446
30°C	1	-1.6433	1.20575	.553	-5.5046	2.2179
	2	-.0967	1.20575	1.000	-3.9579	3.7646
	3	-.0600	1.20575	1.000	-3.9212	3.8012
40°C	1	-1.5467	1.20575	.597	-5.4079	2.3146
	2	.0967	1.20575	1.000	-3.7646	3.9579
	3	.0367	1.20575	1.000	-3.8246	3.8979
50°C	1	-1.5833	1.20575	.580	-5.4446	2.2779
	2	.0600	1.20575	1.000	-3.8012	3.9212
	3	-.0367	1.20575	1.000	-3.8979	3.8246

Based on observed means.

The error term is Mean Square (Error) = 2.181.

APPENDICES G (3) descriptive statistics for weight loss day 9

Multiple Comparisons

Tukey HSD

(I) VAR00001	(J) VAR00001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	1.5300	1.22612	.617	-2.3965	5.4565
	2	1.4500	1.22612	.653	-2.4765	5.3765
	3	1.6200	1.22612	.576	-2.3065	5.5465
30°C	1	-1.5300	1.22612	.617	-5.4565	2.3965
	2	-.0800	1.22612	1.000	-4.0065	3.8465
	3	.0900	1.22612	1.000	-3.8365	4.0165
40°C	1	-1.4500	1.22612	.653	-5.3765	2.4765
	2	.0800	1.22612	1.000	-3.8465	4.0065
	3	.1700	1.22612	.999	-3.7565	4.0965
50°C	1	-1.6200	1.22612	.576	-5.5465	2.3065
	2	-.0900	1.22612	1.000	-4.0165	3.8365
	3	-.1700	1.22612	.999	-4.0965	3.7565

Based on observed means.

The error term is Mean Square (Error) = 2.255.

APPENDICES G (4) descriptive statistics for weight loss day 12

Multiple Comparisons

Tukey HSD

(I) VAR00 001	(J) VAR00 001	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
CONTRL	1	1.5300	1.23008	.619	-2.4091	5.4691
	2	1.4000	1.23008	.678	-2.5391	5.3391
	3	1.6333	1.23008	.572	-2.3058	5.5725
30°C	1	-1.5300	1.23008	.619	-5.4691	2.4091
	2	-.1300	1.23008	1.000	-4.0691	3.8091
	3	.1033	1.23008	1.000	-3.8358	4.0425
40°C	1	-1.4000	1.23008	.678	-5.3391	2.5391
	2	.1300	1.23008	1.000	-3.8091	4.0691
	3	.2333	1.23008	.997	-3.7058	4.1725
50°C	1	-1.6333	1.23008	.572	-5.5725	2.3058
	2	-.1033	1.23008	1.000	-4.0425	3.8358
	3	-.2333	1.23008	.997	-4.1725	3.7058

Based on observed means.

The error term is Mean Square (Error) = 2.270.

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MINIMALLY PROCESS OF HYBRID SWEET CORN (BIG FRUIT, 926) BY USING DIFFERENT TEMPERATURE HOT WATER TREATMENT - AZIRAH BT AKBAR ALI