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Influence of Varietal Difference on Qualities of Osmosized Tomato in the South Western Nigeria

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Abstract
Mechanism of mass transfer phenomena of three major varieties available in the South-western Nigeria market are Roma-VF Koledowo and Ibadan-Local variety. Tomato varieties pre-treated in a binary (sugar and salt) osmotic solution of three solution concentration; three temperature; five osmotic time and fruit to solution ratio 1:10 was studied by developing a conceptual model to describe the Water Loss and Solid Gains. Initial moisture content was determined using the AOAC standards. Statistical analyses of the data within and across varieties were carried out. This study therefore investigated the effect of varietal difference on the qualities of osmosized tomato i.e. the highest water loss and least solid gain. Effect of pretreatment varies with variety with a mean water loss range value of 0.2615-0.3031. Water-loss and Solid gain were significant ($p \leq 0.05$) for all variables considered. Koledowo with the thickest skin had the least owing to its ability to allow moisture migration
Keywords: Water loss, Solid gain, Osmotic time, Varietal difference, Pretreatment

1 Introduction

Vegetables and fruits are one important aspect of the diet in Nigeria, even throughout the world because of their nutritional value (Ngoddy and Koronye, 1985) but they are usually in short supply during the dry season because they are perishable crops which deteriorate within a few days after harvest (which occur mainly in the rainy season). Preserving these crops in the fresh state for months has been a problem that is yet to be solved. (Tunde- Akintunde *et al*., 2003).

Tomato production in Nigeria has more than doubled in the last 10 years and the production in 2001 alone was about 879,000 Tonnes (Akanbi and Oludemi, 2003). It is a commercially important vegetable throughout the world both for the fresh-fruit market and the processed food industries (Antherton and Rudich, 1986). Dry season tomato like some other vegetables such as pepper, onions and green leaves are grown predominantly in the northern part of Nigeria under irrigation due to ecological factors. There are several tomato cultivars grown in Nigeria, but their availability is sometimes restricted to certain regions of the country. The three most commonly available tomato cultivars in the South-western Nigeria market are: Ibadan-Local, Roma-VF and Ife-1 (Koledowo) (Akanbi and Oludemi 2003). Among these available tomato cultivars in the Southwestern Nigeria market is Ibadan-Local, a variety with higher fruit yield and longer fruiting tendency which has received little or no significant attention because of the higher preference of other cultivars to it.

Estimates of the post-harvest losses of food grains in the developing world from mishandling, spoilage and pest infestation are put at 25 percent (25%) (FAO, 2007). This means that one-quarter of what is produced never reaches the consumer for whom it was grown, and the effort and money required to produce it are lost-forever. Fruit, vegetables and root crops are much less hardy and are mostly quickly perishable and become unfit for human consumption. Estimates of production losses in developing countries are hard to judge, but some authorities put losses of sweet potatoes, plantain, tomatoes, bananas and citrus fruit sometimes as high as 40 percent (40%), or half of what is grown (FAO, 2006). Reduction in this wastage, particularly if it can be economically avoided, would be of great significance to growers and consumers alike.

Oyeniran (1988) reported that losses as high as 50% are not uncommon in fruits and vegetables between rural production and town consumption in the tropics. A study conducted in Nigeria showed that losses up to 20% occur in some cases in fresh tomatoes, pepper and onions transported from the production areas in northern Nigeria to an urban wholesale market in Southwestern Nigeria (Olorunda and Aworh, 1983).

2 Drying of fruits and Vegetable

Drying is the most common form of food preservation and it extends the shelf-life of food. The major objective in drying agricultural product is the reduction of the moisture content to a level, which allows safe storage over an extended period. Also, it brings about substantial reduction in weight and volume, minimizing packaging, storage and transportation costs (Okos *et al*., 1992). Traditionally, tomatoes are dried in the open air and exposed to the sunlight which usually takes time depending on the variety of tomato, the humidity in the air during the drying process, the thickness of the slices or pieces, and the efficiency of the dehydrator or oven (Kaur *et al*., 1999). This practice of sun drying is a common method and it has the advantages of simplicity and the small capital requirement yet it has several constraints such as: it is time consuming, prone to contamination with dust, soil, sand particles birds and insects and weather dependent (Ibrahim and Mehmet, 2002).

There are several basic drying methods that are commonly used domestically and they include: Air or oven drying, solar drying and sun drying. These drying methods have however proved from different studies to be deficient hence, the introduction of a dehydration method called Osmotic Dehydration which is capable of reducing the moisture content of foods by 50%. Fruits and vegetables are subjected to pre-treatment before drying them with a view to improve their drying characteristics and minimize adverse changes during drying. Such pre-treatment may include alkaline dips, sulphiting, osmotic dehydration, etc. However, pre-treatment excluding the use of chemicals may have greater potential in food processing (Ade –Omowaye *et al*., 2003). This explains why it is used as a pre-treatment/pre-processing method to be followed by other drying methods.

3 Research Objectives

The objectives of this research work therefore include:
To subject three varieties of tomato to different pretreatment conditions with a view to identify the particular pretreatment condition that will give the best qualities and the effect of varietal difference on the osmosized fruit i.e. the water loss (W_L) and the solid gain (S_G)

4 Research Methodology

Three varieties of mature ripe tomato: Ibadan-Local variety (*L. esculentum Mill. CV)*, Roma – VF variety (*L. esculentum Mill. CV*) and Wild cultivar (Koledowo) of known agricultural history were used for this study. Roma VF variety was purchased from Atakunmosa market, Ilesa, Osun State in their fresh ripe state, the Ibadan-Local variety seed was purchased from Nigeria Seed Service (NSS), Ibadan to ascertain its genetic purity and was thereafter planted on the Teaching and Research Farm of Osun State College of Education, Ilesa, Osun State, while the wild cultivar was obtained from a local farmer from Kajola village via Ilesa, Osun state. This was done to ensure that the varieties used covered the commonly used tomatoes from the South-western market, research institute and on- farm. The tomatoes were stored in a well ventilated room at 30 ± 2^oC. Average moisture content of the varieties was 96.7%, 95% and 96% respectively. Commercial sugar (Sucrose) and salt (NaCl) were purchased from a local market in Ilesa.

5 Experimental Procedure/Methodology

The osmotic dehydration process can be represented by two parameters:

Water loss (W_L)

The solid gain (S_G)

The solid gain represents the amount of solid that diffuses from the osmotic solution into the Tomato less the solid of the tomato that is lost to the solution. The values of water loss (W_L), percentage weight reduction (%WR) and solid gain (S_G) have been presented by Mujica-Paz *et al*., 2003 and modified by Agarry *et al.*, 2008.

$$WL = \frac{(M_o - m_o) - (M_t - m_t)}{M_o} \qquad (1)$$

$$S_G = \frac{m_t - m_o}{M_o} \qquad (2)$$

Where:
M_o is the initial weight of fresh tomato,
m_o is the dry mass of fresh tomato,
M_t is the mass of tomato after time t of osmotic treatment and
m_o is the dry mass of tomato after time t of osmotic treatment .

The research methodology was in two parts viz:

1. Osmotic dehydration of all the varieties to obtain samples
2. Statistical analysis (using the SPSS package) of the various effect of the osmotic variables within and across variety on the water Loss, solid gain weight reduction, and residual water to check the highest/ lowest mean.

Results was analysed using the SPSS 17 software and STATA package. A multivariate analysis using the components analysis was carried out for the 5 factors using a 5x3x3x3x3x2x1 complete randomized design (Time of removal from the osmotic solution/ /Temperature of immersion/Solution Concentration/Varieties /replications / Drying methods used and Geometry). This gave a total of 810 samples (Eight Hundred and Ten).

6 Results and Discussion

Effect of variety on Water Loss and Solid Gain

Results obtained show that water loss differs with varieties and the osmotic treatments that gave the highest water loss also differ with varieties. This is due to the genetic difference that exists between these varieties. Water loss and solute gain kinetics first depend on the vegetal tissue properties (possibly affected by heat or chemical pretreatments, or freezing). It also depends on operating variables, such as specific surface area of food pieces, temperature, time duration, concentration and composition of the solution (i.e. solute molecular weight and presence of ions) and mode of phase contacting (solid/liquid phases). This agrees with the finding of Azoubel and Murr, 2000 that factors that affect properties of osmotically dehydrated products depend on product characteristics such as cultivar, variety, ripeness degree, and the tissue microstructure. The limiting factor for water removing from whole tomato is water penetration through the skin, as dehydration kinetics is governed predominantly by the skin permeability (Lerici et al., 1985). The thick epicuticular waxy layers are resistance to mass transfer. The lightly packed cellular structure of the epicarp under the skin is composed of small cells with thick cell walls and a large amount of middle lamella components. Even within variety, sugar and salt concentration in the solution greatly affected solid gain.

Ibadan- Local variety had the highest mean of 0.3031 water loss at a treatment of 45g of sucrose with 15g of salt in an osmotic solution temperature of 50^{o}C (0.3005), Koledowo variety had its highest water loss mean of 0.3005 at 40g sucrose, 20g of salt and 50^{o}C solution temperature of 0.2615.

Solid gain was positively influenced in the wild (Koledowo) variety under any condition with a mean value range of 0.001 in 40/20/30 and 0.1 in 45/15/40 (Fig. 6). A negative effect under some treatments was noticed for both the Roma-VF and Ibadan-Local varieties (Fig. 7 to 9)

Figures 1 to 6 show the effects of different solution concentrations on water loss at different temperature for the three varieties. The graphs show that while the local and Roma variety displayed similar pattern, an erratic graph was recorded of the Koledowo variety and in some cases moisture movement was recorded negative in the first thirty minutes of the osmotic dehydration process (as it so in the case of 45/15/10 and 50/10/40).

At the point where the highest mean of WL was observed (45/15/50), water loss was observed to increase until the third hour of immersion. At 40/20/40, water loss increased remarkably for the first two hours when water loss starts to decrease. This observation was also noted by Mandala *et al*., 2005. It is worth noting that at some concentrations (40/20) at 30^{o}C, the effect of varietal difference was clearly seen as the rate of water loss increased and stopped at 90 minutes was observed for most of the varieties and this is not peculiar to a particular solution concentration or temperatures when thereafter it (W_L) picks up again.

From the findings of the research work therefore, varietal difference played a key part in the factors that affect the rate of osmotic dehydration. In Appendix 1 Ibadan – Local and Roma variety had most of its values aligning with each other. Maximum/highest water loss took place at a combination of 45/15/50^{0}C (0.3031) and the least at 40/20/50 in Ibadan – Local, Roma had its highest water loss value also at 45/15/50 (0.2615) and least at 50/10/30 (0.1427) while Koledowo had the highest WL value at 40/20/50 (0.005) and least value at 45/15/50 (0.1958).

A possible explanation for this is that Koledowo variety been a mixed breed of the Roma and Ibadan local variety combines the genetic characteristics of both varieties and hence, will possibly not require the same conditions to effect water loss. Since osmotic dehydration involves removing moisture from a region of higher concentration to lower concentration, the characteristics of the endosperm and the cellular structure will play a very vital role in allowing moisture to pass through it.

7 Recommendation

The S_G and W_L values of osmosized tomato depended on immersion time, sugar and salt, variety of the fruit and process temperature.

Samples osmosizes in 45/15/50 had better physical characteristics than those treated at lower concentration.

The WL and weight reduction/loss during O.D. of tomato fruits were influenced positively by increase in temperature while solid gain was influenced by the interaction of the temperature and concentration of both the sugar and salt in the osmotic solution.

The epiticular outer skin of the Koledowo variety impeded moisture migration irrespective of the time and solution concentration (similar conclusion was made by Raji *et al.,* 2010).

Variety played an important role in determining the concentration and time of process.

A combination of 45/15/50 osmotic process variables was recommended for highest WL, least SG, highest weight reduction, least moisture content and least residual water.

Binary sucrose/Nacl solutions are suitable to dehydrate tomato fruit irrespective of the variety.

A solution temperature of 50^{o}C was found desirable optimum quality (water loss, solid gain and weight reduction.

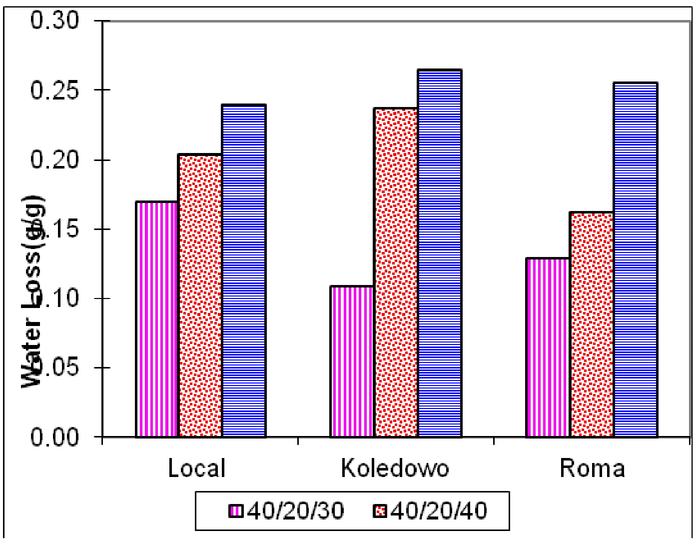

Figure 1 Effect of solution concentration (40/20) on water loss at different temperature

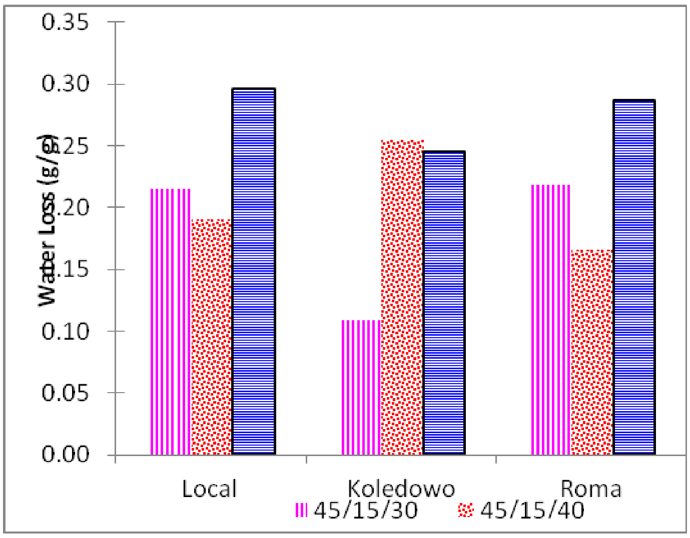

Figure 2 Effect of solution concentration (45/15) on water loss at different temperature

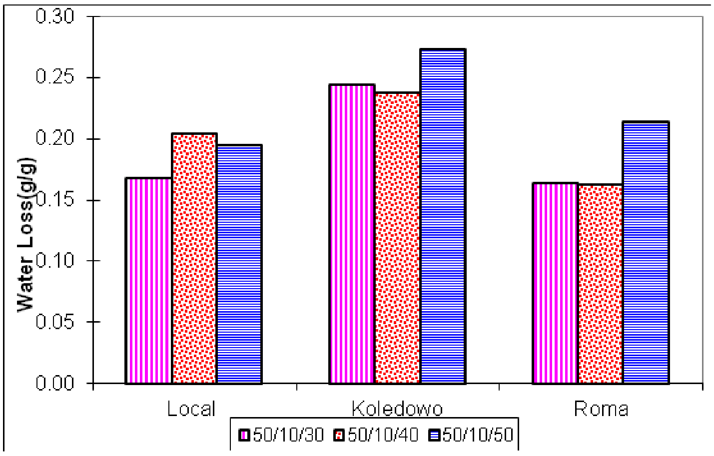

Figure 3 Effect of solution concentration (50/10) on water loss at different temperature

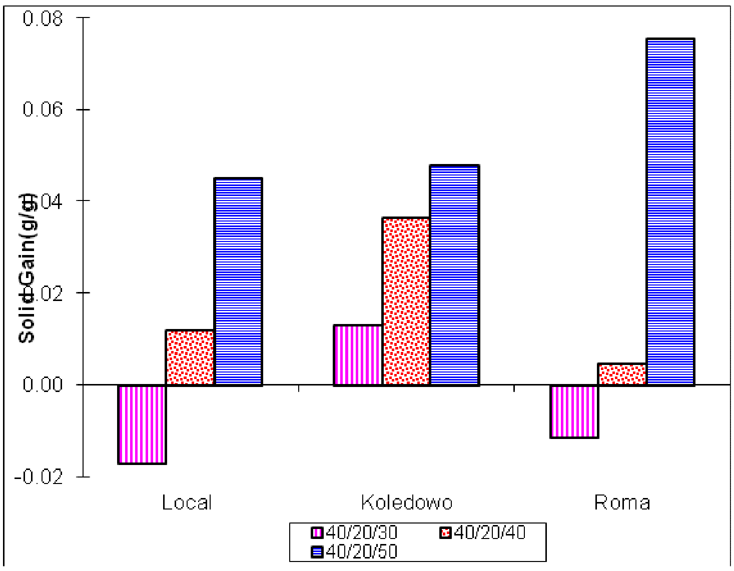

Figure 4 Effect of solution concentration (40/20) on solid gain at different temperature

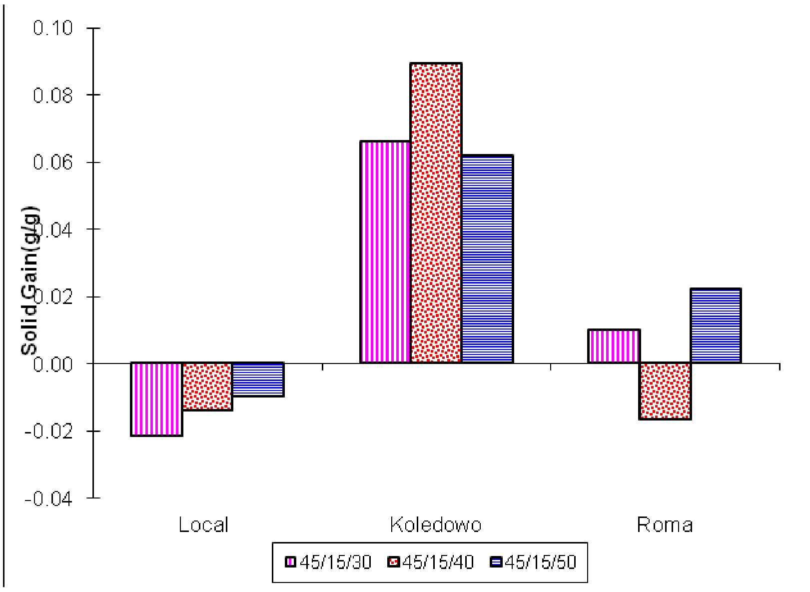

Figure 5 Effect of solution concentration (45/15) on solid gain at different temperature

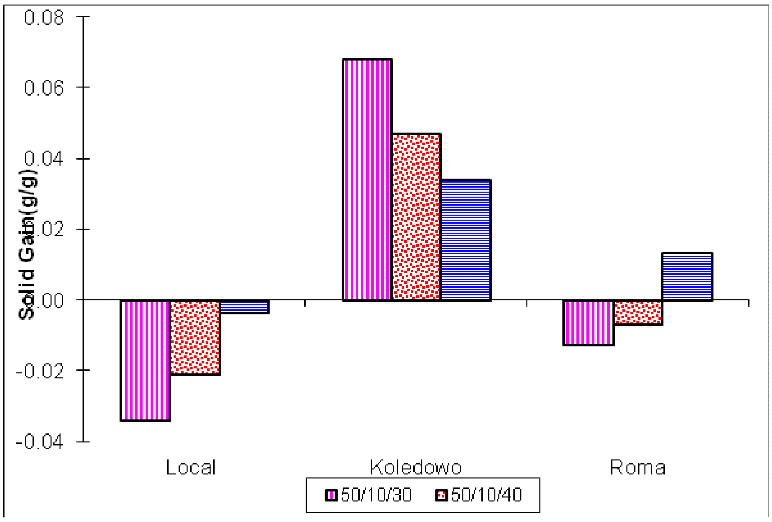

Figure 6 Effect of solution concentration (50/10) on solid gain at different temperature

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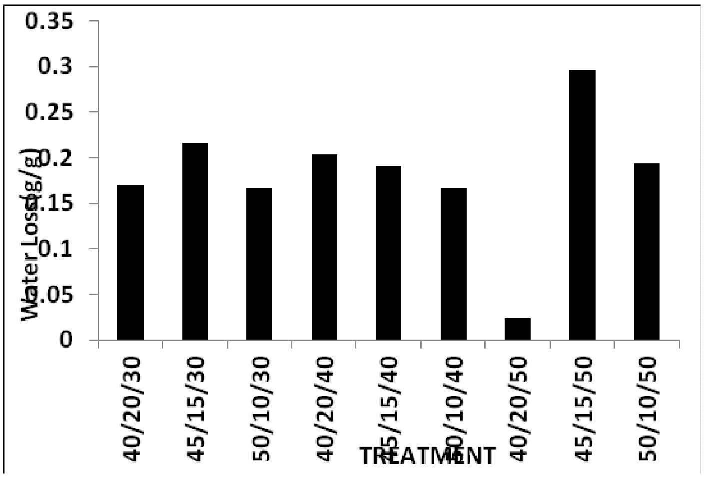

Figure 7: Effect of different conc. and varying temp. on water loss in Ibadan-Local

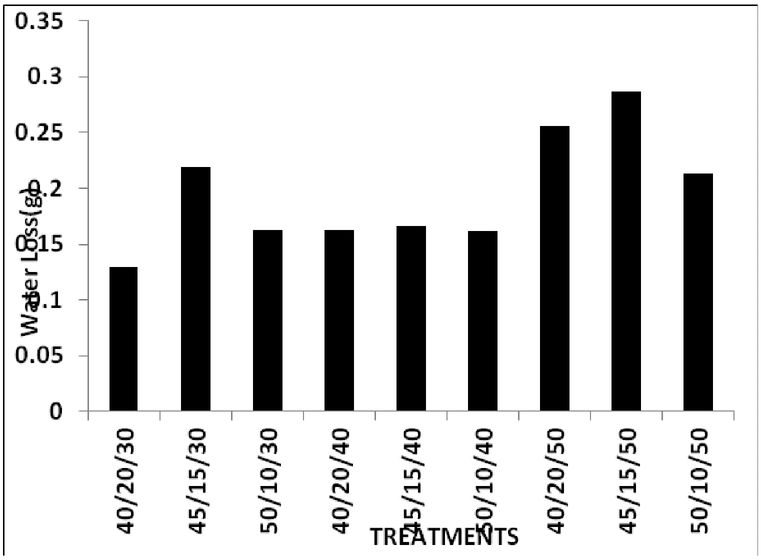

Figure 8: Effect of different conc. and varying temp. on water loss in Roma variety

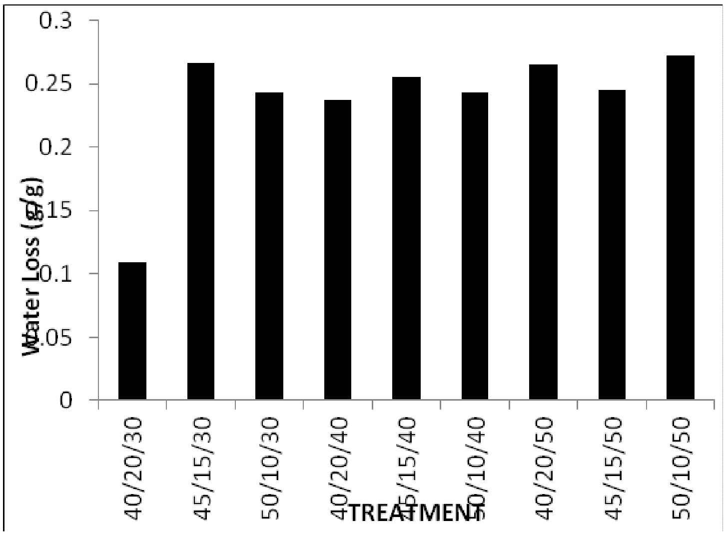

Figure 9: Effect of different conc. and varying temp. on water loss in Koledowo variety

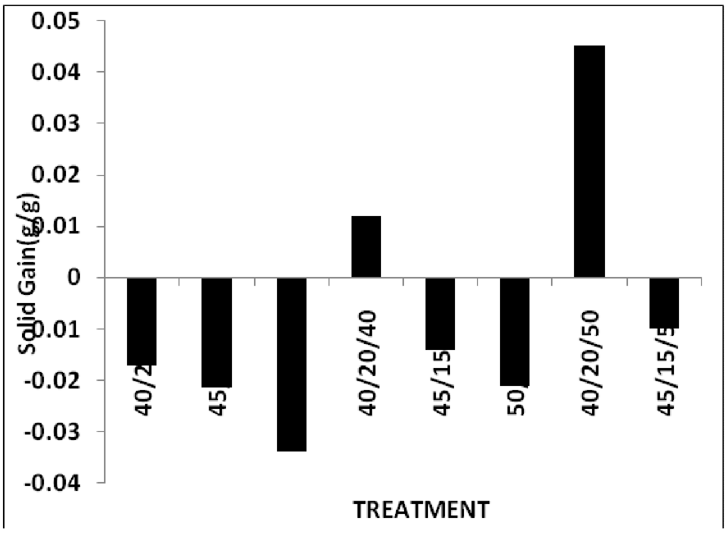

Figure 10 Effect of different conc. and varying temp. on solid gain in Ibadan-Local variety

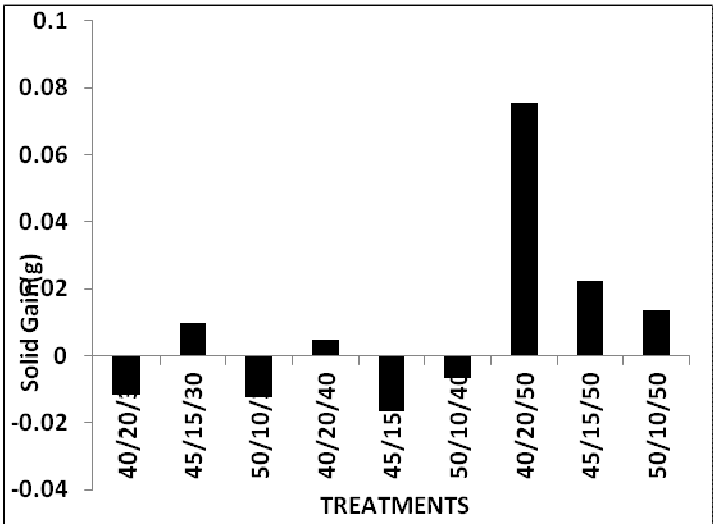

Figure 11 Effect of different conc. and varying temp. on solid gain in Roma variety

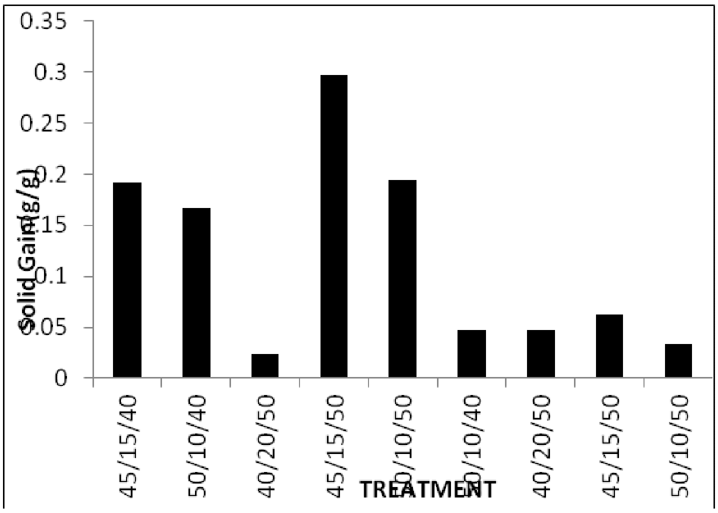

Figure 12 Effect of different conc. and varying temp. on solid gain in Koledowo variety

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