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Optimum Drying Condition for Three Varieties of Pre-Treated Tomato (*Lycopersicum Species*) in South-Western Nigeria

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Abstract-- **In Nigeria and most developing countries, tomatoes (Lycoperscium esculentum) production is seasonal, geographical and are usually in short supply during the dry season. Storing them in the fresh state has been a problem. There is still a dearth of information on the optimum condition of drying with comparable characteristic on rehydration. This study therefore investigated the optimum drying conditions of the south-western Nigeria market tomato varieties i.e. Roma-VF, Koledowo and Ibadan-Local varieties and the mass transfer kinetics. Pre-treatment in a binary (sugar and salt) osmotic solution of concentration (45/15, 40/20, 50/10), temperatures (30, 40, 50), soaking time (30, 60, 90, 120, 180min) and fruit to solution ratio of 1:10 was studied. Drying was monitored at three temperatures (40, 50 and 60^{0}C) until equilibrium weight was achieved using the oven dry method. Optimum condition was based on highest water loss, weight reduction and least values of solid gain, moisture content and residual water. Results of water loss and solid gains were significant ($p<0.05$) for all variables considered. Drying occurred in the falling rate phase and optimum condition of 45g sugar, 15g salt, 50^{o}C solution and drying temperature has been established. Moisture transfer is by diffusion.**

Keywords-- **Osmotic dehydration, Water loss, Solid gain, Drying, Tomato, Optimum condition**

I. INTRODUCTION

There are three most common varieties of tomato in Southwestern Nigeria markets are Roma-VF (*Lycopersicum esculentum* Mill), Wild cultivar *Koledowo* (*Lycopersicum pimpinellifolium*) and Ibadan-Local (*Lycopersicum esculentum* CV*)* (Akanbi and Oludemi 2003) despite the very many varieties of Tomato that are grown all over the world and the vital role it plays in daily dietary intake because of its seasonal and geographical nature.

They are usually in short supply in dry season because of their perishable nature and storage in the fresh state still poses challenge to researchers(Tunde–Akintunde *et al*., 2003).

Drying characteristics of fruits and vegetables have been widely reported to be improved by pre-treatment methods but there is insufficient information on the optimum condition of drying of these three varieties and most especially the indigenous variety (Ibadan – Local), a variety with higher fruit yield and longer fruiting tendency.

The cost of transportation, impact of transportation, cost of storage structure(s), and the high selling price of the dry season tomato i.e. Roma – VF Variety which is indigenous to the northern part of the country can be avoided if the Ibadan-local variety can be dried and preserved with a system that required minimum use of energy and will produce an acceptable product on re-hydration. The local variety contains a very high percentage of titrable acid and pH values (because of the presence of citric and malic acids which are required for best flavour, palatability and its influence on the brightness of color, stability, consistency and the keeping quality of the product (Kaur *et al.,* 1991). One of the most energy- conserving means of removing moisture from a food piece is by pre-treating the product osmotically, thereby reducing the moisture content by about 50%.

Drying is the most common form of food preservation and it extends the shelf-life of food (Raji *et al*., 2010). 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. The main advantage of Osmotic dehydration is its influence on the principal drying method, shortening of the drying process (Ertekin and Sultanoglu, 2000), resulting in lower energy requirements.

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It also offers higher retention of initial food characteristics, such as colour, aroma, nutritional constituents, and flavor compounds (Beaudry 2001; Jalali *et al.,* 2008) longer shelf life (Segu *et al*., 2006). In general the combination of osmotic dehydration with conventional drying method has been proposed for fruits and vegetables by many authors.

The study therefore aimed at

i. Identifying the optimum drying condition that will best preserve the qualities of the osmosized fruits i.e the water loss (WL) and the solid gain (SG) and weight reduction
ii. Predicting the moisture transfer in Tomato and thereafter compare it with some existing models that have predicted mass transfer kinetics.

II. 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 in their fresh ripe state, the Ibadan local variety seed 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. while the wild cultivar from a local farmer in Ilesa. Commercial sugar (Sucrose) and salt (NaCl) were purchased from a local market in Ilesa.

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)

Osmotic Dehydration of Samples

Osmotic solutions were prepared by mixing a blend of 40g/20g, 45g/15g and 50g/10g of sucrose/Nacl with 100g of distilled water i.e (60g/100g solute/water). Tomato samples of the same geometry (half sliced) were used. The fruits (16g) each were placed in 250ml beakers, containing 160g of osmotic solution. An excess of osmotic solution (fruit to solution ratio of 1:10) was used to limit concentration changes. The samples were then immersed in sucrose-salt solutions in a water bath wherein temperature variation was maintained not more than ±1°C. (10 shaker Tecnal TE 421 Model) previously brought to a relatively higher temperature, and kept at 30, 40, 50°C temperatures.

Samples were removed from the osmotic solution at 0.5, 1.0, 1.5, 2.0 and 3.0h of immersion (Azoubel and Murr 2000), drained and the excess of solution at the surface was removed with absorbent paper (To eliminate posterior weight), and weighed using a top loading sensitive electronic balance (Mettler, P163). The water loss and solid gain were determined by gravimetric measurement (Agarry *et al*., 2008). The experiments were carried out at the Multidisciplinary Central Research Laboratory, University of Ibadan, Ibadan.

Statistical analysis was carried out within and across the varieties to determine the variety with optimum response and the optimum condition. The best variety was later pre-treated using the optimum condition, dried at 40, 45 and 50°C and drying kinetics of these osmotically treated samples of tomato and the control, untreated sample were then subjected to oven drying at 40, 45 and 50°C. The moisture ratio, MR is the ratio of free water still to be removed at time t to the total free water initially available in the food

Results was analysed using the SPSS 17 software and STATA package. The osmotic dehydration process can be represented by two parameters:

Water loss (WL)
The solid gain SG)

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

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

$$SG = \frac{m_t - m_o}{M_o} \qquad (ii)$$

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 moisture ratio, MR was calculated from the results using:

$$MR = \frac{M_t - M_e}{M_o - M_e} \qquad (iii)$$

Where, M_t is the moisture content of Tomato slab after time, t; M_e is the moisture content of tomato slab at equilibrium (gH_2O/g dry solid) and M_o is the moisture content of tomato slab prior to O.D ($g\ H_2O/g$ dry solid).

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III. RESULTS AND DISCUSSION

Water loss differed with varieties and the osmotic treatments that gave the highest water loss also differed with 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). Factors that affect properties of osmotically dehydrated products depend on product characteristics such as cultivar, variety, ripeness degree, and the tissue microstructure (Azoubel and Murr, 2000). 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. 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 and also the Roma variety with a mean W_L of 0.3005 both at a treatment of 45g of sucrose with 15g of salt in an osmotic solution temperature of 50^{o}C and 50^{o}C drying temperature. Koledowo variety had its highest water loss mean of 0.2615 at 40g sucrose, 20g of salt and 50^{o}C solution temperature and 50^{o}C drying temperature (Fig. i)

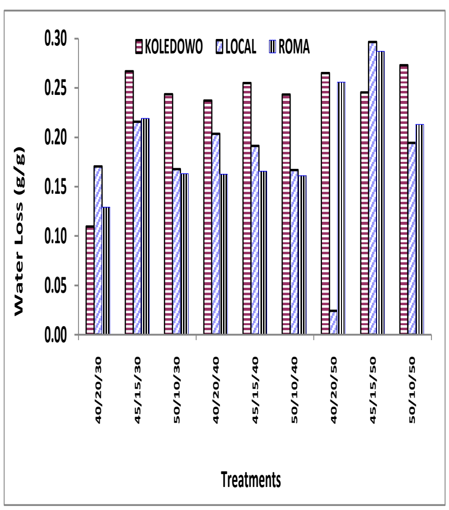

Fig i: Effects of different concentrations on water loss

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. A negative effect under some treatments was noticed for both the Roma-VF and Ibadan-Local varieties (Fig. 2).

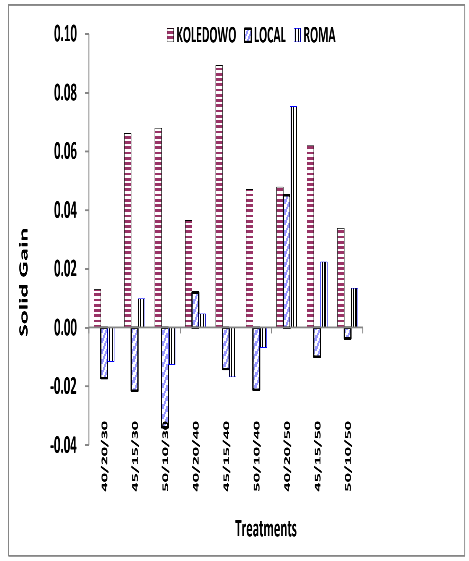

Fig ii Effects of different solution concentrations on solid gain

It was noted that it took a comparatively longer time to dry an untreated sample even under the same drying temperatures. This is a pointer to the fact that pretreatment increases the drying characteristics of fruits and reduces the overall drying time.

Moisture content was observed to decrease with osmotic time and solution temperature. Low solution temperature does not favour water loss, hence it will not favour moisture content. Since osmotic dehydration treatment aims at reducing the moisture content considerably to about 50%, a combination of 45/15/50 favoured Roma and Ibadan – local variety, while the Koledowo variety was favoured by an osmotic concentration of 40/20 and temperature of 500c. This consequently affected the percentage of residual water with 45/15/50 favouring the reduction of residual water in Roma (63.9583%), Ibadan-local (64.4792%) and Koledowo variety at 40/20/50 (65.3124%).

Local variety responded favourably to all treatments and the colour (outlook) after drying at 50^{0}c was comparable to the other varieties of interest to consumers. (Colour plays a very important role in products acceptability by consumers) Raji *et al.*, 2010. This shows that at the recommended processing condition, Ibadan local variety retained considerably its colour and having lost enough moisture to reduce the watery paste it makes when used in making stews).

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IV. CONCLUSION

Optimum pre-treatment condition of 45/15/50 osmotic process variables was recommended for highest WL, least SG, highest weight reduction, least moisture content and least residual water in both Roma and Ibadan local, while 40/20/50 pretreatment condition was recommended for Koledowo variety. As samples osmosed in 45/15/50 had better physical characteristics than those treated at lower concentration.

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