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# Comparative Evaluation of Pot-in-Pot and Metal in Pot Evaporative Cooling Systems

**Olaifa, O. Peter, Osaguona, P. O.**

Department of Animal Production Technology,
Federal College of Wildlife Management, New Bussa, Nigeria

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**ABSTRACT**

Two methods of evaporative cooling system were compared to ascertain the most effective method for the storage of vegetables and okra in New Bussa, Niger State, Nigeria. Two different sizes of earthen pots were installed on a small hole. A small clay pot with bottom surrounded with polythene to prevent leakages was kept inside a bigger clay pot and the inter space was filled with river-bed sand which was made moist always by adding water thrice a day; In the morning, afternoon, and evening. The pot had a wooden cover. The thermometer and hygrometer were installed to take the record of temperature and relative humidity at interval of time for 14days. The same procedure was repeated in metal in pot but the smaller pot was replaced with 18 liter tin of kerosene. The result obtained showed that there were significant differences ($p < 0.05$) in the values of temperature recorded. The highest temperature for both ESC was recorded in the afternoon and the least in the morning; this is due to high intensity of the sun in the afternoon and cooling in the morning. Also, the highest relative humidity for both ESC was recorded in the morning due to high cooling effect. It was concluded that pot in pot ESC was more effective compared to metal in pot ESC for storing Okra but none was suitable for storing vegetables in New Bussa region of Niger state, Nigeria and other places of equal climatic data and storage condition.

***KEYWORDS:*** *vegetables, cooling, okra, storage, evaporation*

## INTRODUCTION

Cooling through evaporation is an ancient an effective method of lowering temperature. Both plant and animal used this method to lower their temperature. Through the method of evapo-transpiration for example remains cooler than their environment.

The basic principle relies on cooling by evaporation. When water evaporates, it draws energy from its surrounding which produce a considerable cooling effect evaporative cooling occur when air is not too humid passes over a wet surface. The faster the rate of evaporative the greater cooler depends on the humidity of the surrounding air.

Evaporative cooling is dependent on the air it is necessary to determine the weather condition that may be encountered to properly evaluate the possible effectiveness of evaporative coolers Mentzer and Dale (1960) on the other hand the amount of water vapor that can be taken up and held by the air is not constant: it depends on two factors: the first is temperature (energy level) of the air, which determine the potential of the taken up and hold on water vapor. The second involve the availability of water, if little or no water is present, the air will be unable to take up very much.

The operational effectiveness of an evaporative cooler is made up of porous material. The water evaporates in to the air, razing the humidity and at the same time reducing the temperature of the air. The extent to which evaporation can be lower the temperature of the container depend on the different between the wet and dry bulb temperature, theoretically, it is possible to bring change in temperature equal to the difference in this two temperature. For example if the wet and dry bulb temperatures were $35^0$C and $15^0$C respectively the maximum drop of temperature due to the evaporative cooling would theoretically maximum temperature drop a substantial reduction in temperature is possible (Babarinsa, 2000).

Reduction in the temperature of fruits and vegetable stored in both pot in pot and iron in pot to retain spoilage is an important benefit of evaporative cooling. Though, it is not only one evaporation not only lowers the air temperature surrounding the produce, it also increase to moisture content of the air, this helps prevent the drying out of the produce and therefore, extend its shell life. Pot-in-pot are simple designs of evaporative coolers that can be used in the farm. The basic design a bigger pot that hold water, the inner pot and iron stored fruit and vegetable that is kept cool. One adaptation of the basic pot designs is the fermata cooler developed by the food and the nutrition board of India (Roy, 1985). A storage pot is placed in an earthen ware bowl containing water, the pot is then covered with a damp cloth that id dipped in to the water. Water drawn up the cloth evaporates keeping the storage pot cool; the bowl is also placed on wet sand to isolate the pot from the ground.

### Justification

Due to the wide spread of poverty among rural farmers and insufficient power supply in developing countries like Nigeria, which contributes greatly to the loss of harvested agriculture produce requiring to meet fruitful future market, hence, there is need to fabricate tool that will preserve the agricultural perishables such as fruits and vegetable which is evaporative cooling system, therefore looking at effective E.C.S that will be more effective for farmers to store their farm product.

### Objectives

To know which of the E.C.S can be used to extend the shelf life of vegetable and forages.

To determine the effect of temperature on the relative humidity on both pot in pot and metal in pot E.C.S.

### Materials and Methods

**Materials used for Pot in Pot and Metal in Pot include**

- Two larger earthen pot ,small earthen pot and metal
- Sand: which served as the permeable membrane.
- Data measuring device such as: Soil thermometer and hygrometer
- Lid: which serve as pot cover and also iron cover made of wood.
- Water
- Okra

### Research Location

This project was carried out at federal college of wildlife management (FCWM) farm and research site under a tree located at the farm premises. The location is situated between kanji dam and new bussa town along awuru road. It lies between longitude $4^0$ 330N and latitude $7^0 31^0$ E-10E (Onyeanusi, 1998).

### Climate

The average monthly temperature of $34^0$C the highest value being $41^0$C with a mean annual relative humidity of 60% the average annual rainfall is 104.45mm.The first rainfall normally come in March reaches a peak in July to August and decline in September (Onyeanusi, 1998).

### Methodology

Two different sizes of earthen pots were installed on a small hole. A small clay pot with bottom surrounded with polythene to prevent leakages was kept inside a bigger clay pot and the inter space was filled with river-bed sand which was made moist always by adding water thrice a day; In the morning, afternoon, and evening. The pot had a wooden cover. The thermometer and hygrometer were installed to take the record of temperature and relative humidity at interval of time for 14days.The same procedure was repeated in metal in pot but the smaller pot was replaced with 18 liter tin of kerosene as showing in figure 1.

**Figure 1: Diagrams showing pot in pot and metal in pot evaporative cooling systems**

### Installation

The two bigger clay pot are fixed on a small dung ground level and was filled with layers of river bed sand at the bottom and the smaller clay pot is inscribed in to the bigger clay pot likewise 18 litter kerosene tin was inscribed into the bigger pot filled with sand, the thickness of the first layer of sand in the base of the two bigger pots was adjusted so that the small pot and meta is at least 2cm higher than the big pot to avoid water switching into the pots when irrigated. During this procedure the inner pot and metal stay exactly in the middle of the outer pot so that the distance between the pots is identical in all direction. When the sand fills the space between the pots to about 3cm below the edges of the outer clay pots to allow space for wetting, the cooling system were installed and kept under a shade with adequate cross ventilation while wetting was one on regular basis.

## RESULTS

The result obtained from the mean temperature and relative humidity of both evaporative cooling system is presented in Table 1. There were significant differences ($p < 0.05$) in the values of temperature recorded. The highest temperature for both ESC was recorded in the afternoon and the least in the morning; this is due to high intensity of the sun in the afternoon and cooling in the morning. Also, the highest relative humidity for both ESC was recorded in the morning due to high cooling effect.

Table 1: Temperature and relative humidity of pot in pot and metal in pot evaporative cooling systems

| | Temperature ($^0$C) | Relative humidity (%) |
|---|---|---|
| M | * 27.72 | 97.43 |
| | ** 26.95 | 73.27 |
| A | * 32.92 | 47.08 |
| | ** 37.98 | 45.24 |
| E | * 29.68 | 66.30 |
| | ** 28.76 | 65.40 |

*=Pot in pot (PIP) ESC; **= metal in pot (IIP) ESC; M= Morning; A= Afternoon; E= Evening.

## DISCUSSION

Fresh Okra was stored in both ESC for a period of 14 days. The highest temperature was recorded in iron in pot (IIP) in the afternoon, this could be due to the fact that iron as a good conductor could transfer heat to the inner part of the storage device which in turns increases the temperature thereby reducing the inner relative humidity in the afternoon when intensity of the sun is maximum but overall cooling is achieved both in the morning and night. Evaporative cooling occurs when air, that is not too humid, passes over a wet surface, this implies that the faster rate of evaporation cooler depends on the humidity of the surrounding air. The vegetables being perishable, need immediate post-harvest attention to reduce the microbial load and increase their shelf life, which can be achieved by storing them at low temperature and high relative humidity conditions(Amat *et al.,* 2013). Tha and Chopra (2006) reported that the cool chambers are able to maintain temperatures at 10-15$^0$C below ambient, as well as at a relative humidity of 90% depending on the season. Evaporative cooling is an efficient and economical means for reducing temperature and increasing relative humidity of an enclosure and has been extensively tried for enhancing the shelf-life of horticultural produce (Tha and Chopra, 2006; Dadhich *et al*., 2008; Odesola and Oyebuchi, 2009) which is essential for maintaining the freshness of the commodities. The 14 days storage days recorded from this studies is less than 17 days shelf-life of okra reported by Longmone (2003), the observation made from this study shows that both ECS were effective but the inner pot replaced with metal in metal in pot increases the inner temperature thereby reducing the relative humidity which inturns increase the moisture content in metal in pot which increase the deterioration in metal in pot hence, there were little changes in color, freshness and less stronger than those stored in pot in pot , also relative humidity in pot in pot was more than metal in pot which increases the air flow movement in pot in pot, reducing the moisture content which enables the okra to remain fresher without any changes in color. Consequently, it was noted from this work that both ECS were not efficient for storing vegetables within the geographical location where this research was carried out due to an extremely high intensity of the sun, most especially during summer i.e. between February-June. More than 60% of the stored vegetables got perished.

## CONCLUSION

The result obtained from this work showed that pot in pot ESC is more effective compared to metal in pot ESC for storing Okra but none is suitable for storing vegetables in New Bussa region of Niger state Nigeria and other places of equal climatic data and storage condition.

## RECOMMENDATION

Since it was discovered from this work that temperature and air movement is the main factor that determine the shelf-life of Okra, it is therefore recommend that an artificial means of controlling temperature and humidity should be device so as to help farmers of the same climatic data store their vegetables.

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