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Evaluation of Heat-sensitive Micronutrients in Fresh, Sun-dried and Solar-dried Capsicum Varieties Grown in Peru

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Introduction

The genus *Capsicum*, with its center of origin in Central and South America, is an important ingredient in national cuisines as well as one of the most important agricultural export commodities of Peru. Many small scale farmers depend on the cultivation of C*apsicum* species, which are used as both fresh and dried materials. Many studies have documented that C*apsicum* peppers contain high concentrations of vitamins C and E, as well as carotenoids and phenolic compounds with well-known antioxidant properties (Hervert-Hernández et al., 2010).

In Peru, *Capsicum* fruits are traditionally sun-dried in open-field settings. Previously, this was identified as one of the major critical control points for quality assurance (Salvatierra 2010) when considering HACCP principles. However, the practice remains widespread due to low investment and labor costs as well as a lack of feasible alternatives. In such practices, extended drying processes, high relative humidity, moderate to low temperatures, as well as direct exposure to soils and environmental contamination, favor the growth of fungi which lead to the production of aflatoxins. Furthermore, due to direct exposition to the ground the product is also fouled with dirt. Field workers carrying out the drying represent another contamination factor as they directly walk on the product in order to turn the heaped piles of fruits. Similarly, animals in the drying area contribute to contamination of the product as it is not protected in any way. Also the product is not sheltered against climatic factors such as rain or fog (Salvatierra, 2010, Halle, 2010). The aim of the current study was to compare the influence of drying method, namely open field sun-drying versus drying in a solar dryer, with respect to quality content of several different *Capsicum* varieties with regards to carotenoids, vitamin C and E with the goal of preserving nutritional value and providing high-quality dried *capsicum* products.

Material and Methods

This work took place at the field research station ‘Donoso’, in Huaral (about 75 km in the north of Lima) and at the laboratories in Lima, Peru, in cooperation with the National Institute of Agrarian Innovation (INIA) between the end of April and the beginning of September 2011.

For drying experiments, three commercial *capsicum* varieties were used: Ají amarillo (*Capsicum baccatum* var. *pendulum*), ají guajillo (*Capsicum annuum* L.) and ají panca (*Capsicum chinense)*. For micronutrient analysis additionally six red accessions of INIA's genebank were used: INIA maintains a gene bank with many local varieties which are unutilized (Figure 1). These accessions are cropped at Donoso within the general production season from April to July. Samples were harvested on July 18, 2011. Accessions are still not taxonomically identified.

Figure 1. Capsicum varieties used in this work Capsicum chinense Capsicum baccatum Capsicum annuum	
Six accessions of the INIA gene bank	

In this study, the traditional practice of open field sun-drying was compared against advance drying technology using a solar tunnel dryer "Hohenheim type" (Figure 2). To represent traditional drying, fruits were spread on bare soil next to the solar dryer. Three drying curves were formed using the solar dryer, the laboratory dryer at 60°C (control) and by spreading on the ground. During drying ambient data and conditions inside the dryer were evaluated like temperature, relative humidity, solar radiation and air velocity. HPLC analyses were performed to screen for capsanthin, ß-cryptoxanthin, ß-carotene, α-tocopherol, γ-tocopherol and ascorbic acid.

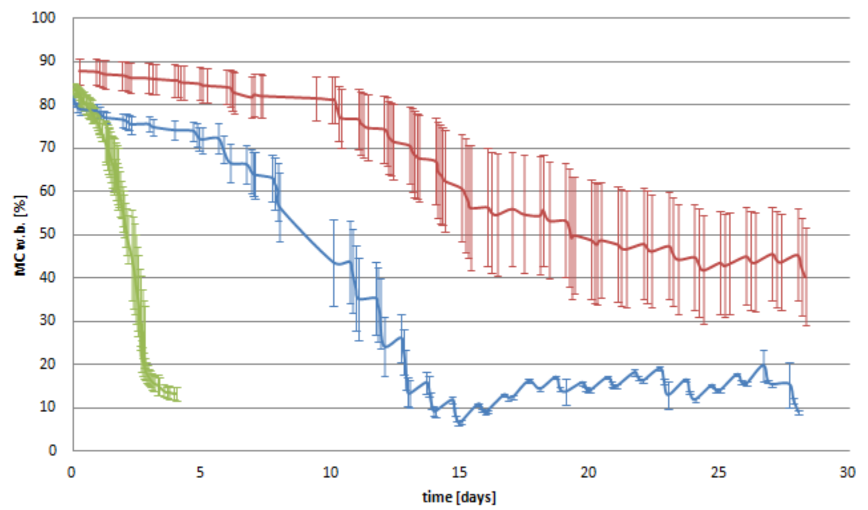
Figure 2: Solar tunnel dryer "Hohenheim type" installed at INIA Donoso, Hural

Results and Discussion

As shown in Figure 3, samples dried faster in the solar dryer as compared with the sun drying samples. It was even possible to reach lower moisture contents with the solar tunnel dryer. This effect could be seen for all three varieties. The control samples dried very fast due to the constant temperature of 60°C throughout the entire drying process. This was mainly due to the fact that samples in the solar dryer and from traditional sun drying experienced fluctuations in temperature and relative humidity between night and day. Drying experiments were carried out under Peruvian winter conditions. That means high relative humidity, not very high temperatures and a clouded sky during the whole day. On many days drizzling rain was observed and high relative humidity even led to rehydration during night. Samples from sun drying never reached moisture contents lower than 20% (wb). During the drying process microbiological degradation was observed (Figure 4). Additionally, many fruits suffered destruction from animals (dogs, insects) and were covered by dust. Solar drying samples were not covered by dust and were protected against direct contact with drizzling rain and animals and therefore reached lower moisture contents between 7.1 ± 0.7 and 23.2 ± 1.4%.

Figure 3. Drying curves for:

C. annuum



C. chinense

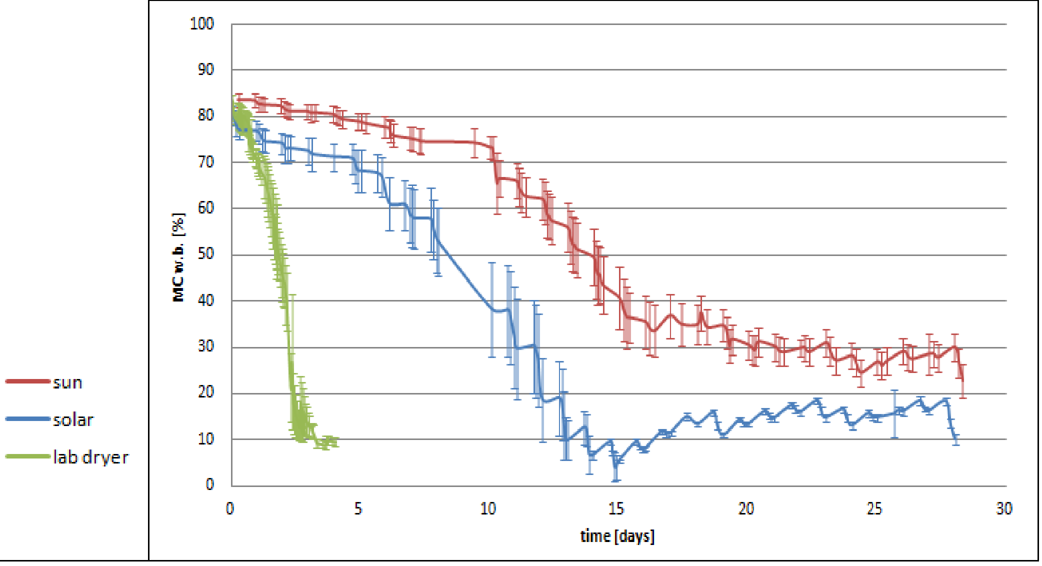
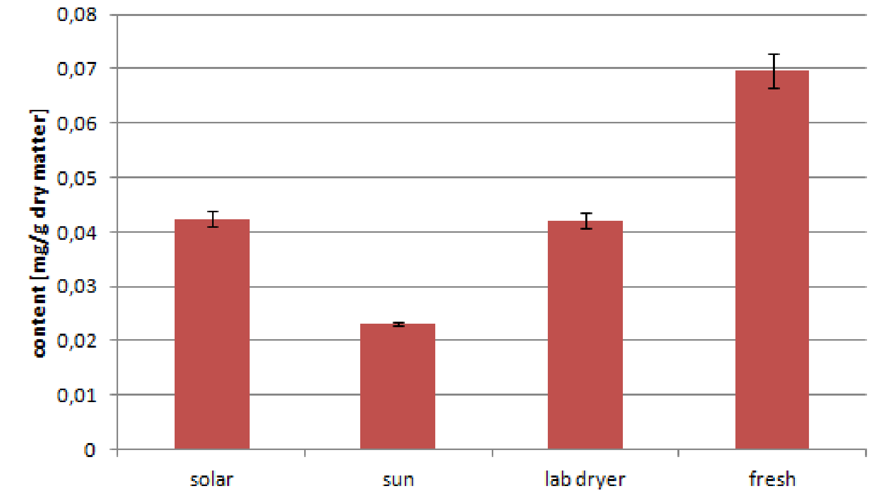


Figure 4. Degradation of sun drying fruits including contamination with fungal species.

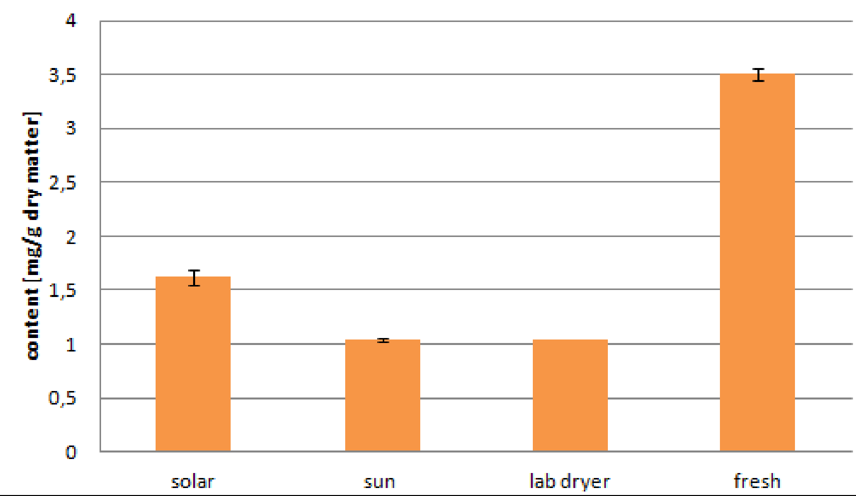
Vitamin C content of gene bank samples was found to be high. Samples contained between 44.49 ±0.21 and 66.21 ±17.63 mg ascorbic acid /100g fresh weight. The analyzed INIA accessions were also rich in carotenoids. *C. baccatum* var. *pendulum* was deficient in capsanthin which is known to occur only in red varieties. According to Figure 5, ß-carotene and ß-cryptoxanthin suffered less destruction in the solar dryer than dried with the open-field sun-drying method. As expected, fresh samples contained higher carotenoid contents as dried material (Figure 5).

Figure 5: Selected carotenoids in fresh and dry samples

Capsanthin in *C. annuum*



Beta-carotene in *C. chinense*



Conclusions

The use of the solar tunnel dryer "Hohenheim type" is highly recommended. Its use shortens drying time and provides more hygienic conditions. Additionally the product is better protected against climate, dust, insects and other animals. Besides that, it is suggested to implement a pre-selection of the *capsicum* peppers before putting them into the dryer. Thus elimination of fruits showing fungal contamination, putridity and damages could be realized to avoid inoculation and spoilage of healthy fruits. Furthermore carotenoids seem to suffer less destruction by the use of the solar tunnel dryer. The climatic conditions in winter near the Peruvian coast represent suboptimal conditions for the use of the solar tunnel dryer. Therefore other climatic regions should favor the drying process more. Drying with the solar tunnel dryer provides high-quality dried *Capsicum* products with better preservation of carotenoids.

As in this work small amounts of *Capsicum* samples were used for drying experiments, studies should be carried out in a completely filled dryer. Also, experimentation on the dryer loaded with larger quantities of fruits would mean large sample population and the use of several dryers at the same time or drying several times in one dryer to allow for more repetitions.

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