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Conservation of Onion and Tomato in Niger - Assessment of Post-Harvest Losses and Drying Methods

Tröger[a], Katharine, Oliver Hensel[b] and Andreas Bürkert[c]

[a] ETH, D-AGRL Student. Email: troegerk@student.ethz.ch
[b] University of Kassel, Department of Agricultural Engineering, Witzenhausen, Germany.
[c] University of Kassel, Department of Organic Plant Production and Agroecosystems Research in the Tropics and Supttropics, Witzenhausen, Germany

Introduction

The production of vegetables during the dry season ("contre saison") has a considerable tradition in Niger. One of the most important is onion, with a yearly production of about 300000 t. The major part is exported to neighbouring and other West African countries, thus contributing an important share to the gross national product (GNP). With about 130000 t produced, tomato is as well important for domestic markets. Onion and tomato are not only consumed fresh but also traditionally sun dried for preservation and used later as a pulverised seasoning. However, conditions for preservation and storage often lead to substantial losses in quantity and quality.

According to literature estimates, generally about 50% of produced fruits and vegetables are lost after been harvested (FAO, 1989). Post-harvest loss is been defined as a "measurable quantitative and qualitative loss of a given product at any moment along the post-harvest chain" (De Lucia and Assennato, 1994) and includes the "change in the availability, edibility, wholesomeness or quality of the food that prevents it from being consumed" (FAO and UNEP, 1981). Post-harvest loss does not equal food loss necessarily (Grolleaud, unknown). Thus, the reduction of post-harvest losses of perishables is of major importance when striving for improved food security in developing countries (Kader, 2005).

The concern of this work was an assessment of the current situation regarding post-harvest losses and handling practices of onion and tomato in Niger as a pre-study to subsequent research of the supervising departments. The aim was, to include several perspectives and to particularly pay attention to current drying methods. The attempt was made to quantify qualitative losses, including microbiological criteria, the contamination with sand, moisture content, and water activity occurring due to different available drying methods. Furthermore, the post-harvest chain was followed up for onion and tomato and interviews with producers, retailers, and consumers were conducted to broaden the picture and to assess potential options for improvements. Overall, the found situation urgently calls for need for action.

Material and Methods

The main study area was the urban agglomeration of Niamey. During the stay between the 4th of September and the 15th of December 2006 several markets in the city were visited to ascertain the origin of offered produce as well as to assess and document handling practises and losses on retail level. The latter was further broadened by conducting surveys of both, retailers and consumers. According to typical current marketing chains, onion production sites in Tabelot (Aïr Mountains) and tomato producing farmers around Niamey were visited. Additionally, focused interviews with several stakeholders were made, to gain further information about production methods, the commercialisation, solar drying initiatives, etc. and secondary literature material was collected.

Traditional sun drying of onion and tomato is common in Niger. As sun drying generally results in produce of minor quality (Axtell, 2002, Adam, 1998) qualitative analyses of sun and solar dried onion and tomato were conducted. During a trial under field conditions in Niamey, persons who used to dry onion and tomato were asked to dry produce the way they would normally do it. Thus, traditionally dried onion and tomato produced by two different farmers (cp. Fig. 3) could be compared with produce made with a natural convection dryer (Coquillage Dryer, cp. Fig. 1) and a forced convection dryer (Icaro Dryer, cp. Fig. 2).

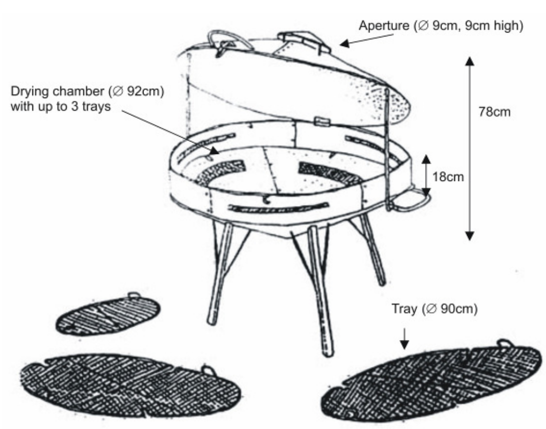

Fig. 1: Natural convection Dryer (Coquillage Dryer)

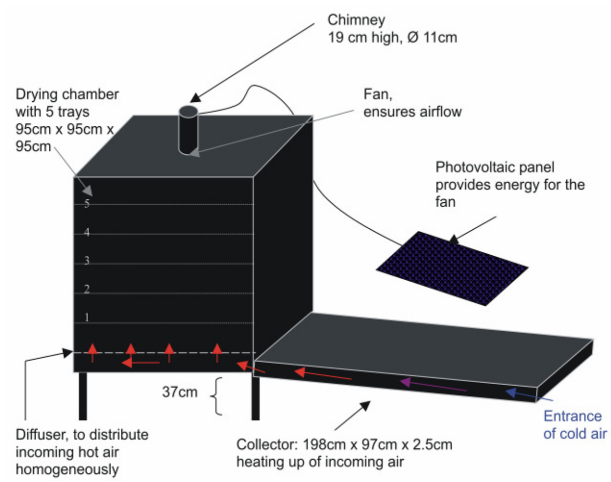

Fig. 2: Forced convection Dryer (Icaro Dryer)

Fig. 3: Traditional sun drying

Additionally, samples of dry onion and tomato purchased on markets were analysed. The samples were tested for residual moisture content, contamination with sand (acid non-soluble ash after Methodenbuch III (Naumann et al, 2004), and some microbiological parameters were quantified, which were total bacteria counts, faecal coliforms, moulds and yeasts, and anaerobic living sulphite reducing bacteria in cfu g^{-1}. Also the performance of the solar dryers was documented and assessed by recording data of temperature and air humidity.

Results and Discussion

During this work the quantity of food losses could not be measured exactly, but documenting material underlines its severity. In case of onion produced in the oasis Tabelot and transported to Niamey, only about 15 % were declared as complete food loss, according to on-site interviews and experience values of locals. However, large quantities of poor quality produce (up to 65 %) were still sold or dried and consumed. The situation was similar in case of tomato. Again, minor quality produce was frequently sold on the markets (cp. Fig. 4). In either case, causes of post-harvest losses were manifold, and included inappropriate harvesting and transport containers, poor road conditions, want of care while handling the produce, lacking proper storage facilities and means of advisory service. In summary shortcomings of controlling and hygienic safety became apparent throughout the marketing chain.

Fig. 4: Market offer. Minor quality of fresh tomato and onion, dry onion, dry tomato (from left)

During the drying trial, traditional sun drying took up to two times as long as solar drying and final moisture contents of the sun dried vegetables were more than twice as high as the solar dried ones (cp. Appendix Tab. 2, Fig. 5, and Fig. 6).

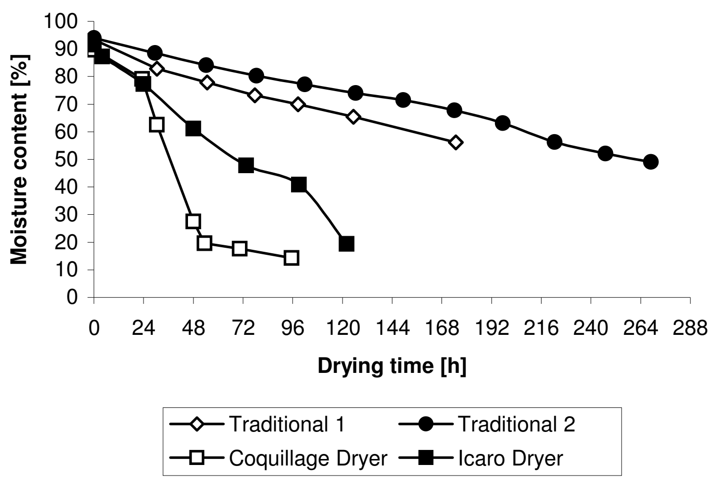

Fig. 5: Drying curve of onion

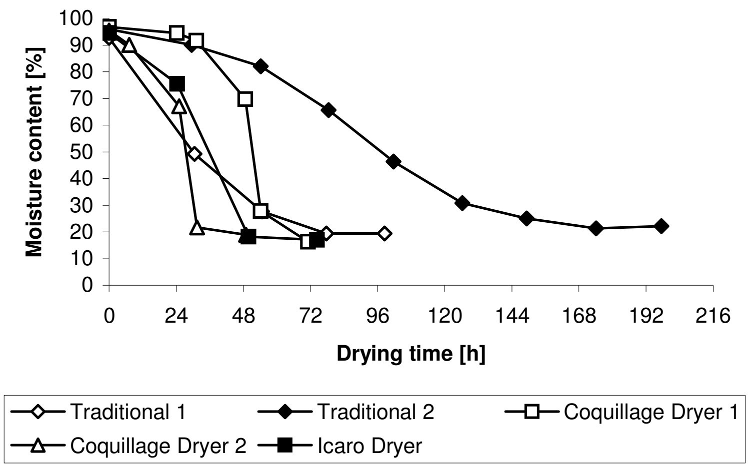

Fig. 6: Drying curve of tomato

A direct correlation could be shown between particle size and drying time and moisture content (Adam, 1998, Epure, unknown). Thus, higher moisture contents of sun dried onion and tomato was probably due to their larger particle size and their mode of preparation as the onion was simply smashed and the tomato was inexactly cut into large pieces. Varying data about recommended final moisture contents were found in the literature, but when applying a general standard of 12 – 22% given by Krämer (2002) the solar dried variants reached these values. However, recommended values were as low as 5-9% (Adam, 1998, Epure, unknown) and therefore none of the analysed produce would allow a successful storage and long shelf life without the risk of microbial deterioration. Additionally, analysed market samples contained less moisture, which is probably due to their age, open storage and a longer drying time.

The contamination levels with sand were clearly reduced when drying onion and tomato with the solar dryers (cp. Appendix Fig. 7 and Fig. 8). During traditional drying, the produce is directly exposed to the sun and not protected from any kind of contamination sources, hence dirt levels were higher. However, since the results varied, traditional drying methods have to be evaluated differentiated and do not necessarily result in disproportionate high levels. Market samples had on average higher contamination levels with sand than the samples from the trial, but their results varied as well quite substantially. Thus, not the mode of preparation itself, but storage and transport conditions influence and contribute to final dirt levels.

Regarding the microbial contamination levels only the dry onion made with the Icaro Dryer, one market sample, and one market sample of dry tomato complied with thresholds given by the literature (cp. Tab. 1). All other produce exceeded one ore more evaluation criterion. Therefore, particularly contamination with coliform bacteria, and yeasts and moulds imply a health risk of the examined produce. Lack of hygienic handling practices, lack of protection to contamination sources, and too weak convection in the solar dryers might have had the most significant contribution to the results obtained. Conclusions about markets samples are difficult to draw, due to lack of further information and potential shortcomings of the analysing method.

Tab. 1: Microbiological analysis of dry onion and tomato

Dry Onion	A_w[1] (30°C)	Flora aerobic mesophile total [cfu g^{-1}]	Faecal Coliforms [cfu g^{-1}]	Yeasts and moulds [cfu g^{-1}]	anaerobic sulphite reducing bacteria [cfu g^{-1}]
Icaro Dryer	0.66	240000	Absent	Absent	>20
Coquillage Dryer 1	0.59	630000	285000	Absent	5
Farmer 1	0.81	222000	10000	Sample with moulds before analysis	1
Farmer 2	0.82	344000	145000	158000	Absent
Market 4	0.49	249000	Absent	Absent	>20
Market 5	0.75	230000	152000	Sample with moulds before analysis	2
Max. reference value[2]	0.7	1000000	100	10000	100
Dry Tomato					
Icaro Dryer	0.48	81000	Absent	14000	1
Coquillage Dryer 2	0.53	-	35000	191000	1
Farmer 1	0.54	340000	Absent	580000	Absent
Farmer 2	0.61	2000	Absent	6000	>20
Market 4	0.33	400000	Absent	Absent	>20
Market 5	0.28	Absent	Absent	Absent	>20
Max. Reference value[3]	0.7	100000	10	1000	100

Surveys with consumers were conducted to asses their quality awareness of fresh and dry onion and tomato. Generally, consumers stated to pay according to produce quality but criteria were appraised differently. Dry onion and tomato were often perceived as produce of minor quality and fresh produce was preferred. One major obstacle to use dry onion or tomato was their laborious preparation as the produce is often very dirty. This result in turn points out the shortcomings of the current drying methods. Furthermore, a comparative consumer survey was done to reveal the potential of improved dry tomato and onion. The majority of the interviewed consumers preferred the solar dried tomato. However, the survey could not reveal whether consumers would really pay higher prices for solar dried produce, provided that those were of superior hygienic quality.

Conclusions and Outlook

Besides the documentation of quantitative post-harvest losses, qualitative losses occurring during drying were exemplary quantified. The data implies that dry produce currently available is very likely to be a health risk. Both currently in Niamey available solar dryers failed to produce dry onion and tomato of superior hygienic quality in comparison to traditional drying. Contamination with sand was significantly reduced when using solar dryers, but microbial deterioration was not prevented. Therefore, the use of the tested devices is not recommendable and alternative theology should be tested and evaluated.

An alarming situation and the need for further research, improved drying methods, and drying devices became obvious. However, the challenge is to create produce of superior quality that is also accepted and adopted by the local consumers. The limited purchasing power and price sensitivity of consumers calls primarily for low cost improvements.

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[1] Calculated using the equation of Oswin (Adam, 1998)
[2] according to the Norme Nigrienne NN 01-05-003, and KRÄMER (2002)
[3] according to the product specifications of SARDES, the Norme Nigrienne NN 01-05-003, and KRÄMER (2002)

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Appendix

Tab. 2: Moisture content of the dry onion and tomato samples from the drying trial

Dry onion variant	Moisture content (%)	Dry tomato variant	Moisture content (%)
Traditional 1	56.1	Traditional 1	19.4
Traditional 2	49.0	Traditional 2	22.1
Coquillage Dryer (natural convection)	14.2	Coquillage Dryer (natural convection) 1	16.3
Icaro Dryer (forced convection)	19.4	Coquillage Dryer (natural convection) 2	18.9
		Icaro Dryer (forced convection)	17.0

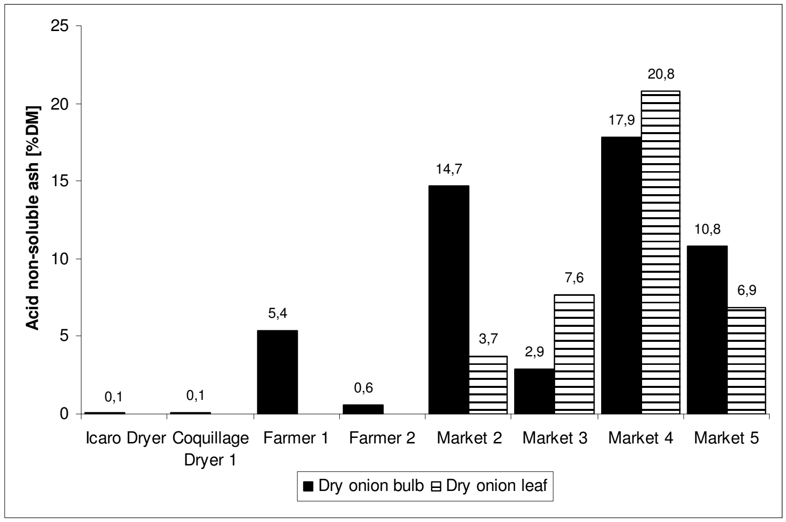

Fig. 7: Amount acid non-soluble ash of onion

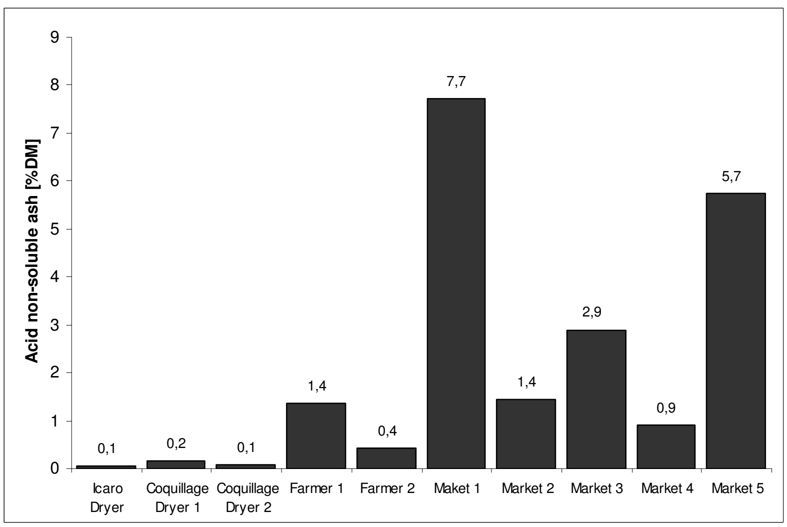

Fig. 8: Amount acid non-soluble ash of tomato