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Quality Standards and Inexpensive Drying Technology for Semi-Dried Jerky in Gialai Province: A Short Review

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Abstract:
The aims of this study were to: (1) review the quality standards for semi-dried jerky and (2) discuss common inexpensive drying methods as a preservation technique on nutrient contents of beef. A quality standard is a composite evaluation of factors that affect palatability of meat. These factors were materials, physicochemical evaluation, contaminated substances, bacteria, and parasites. Furthermore, the reviewed beef drying methods included natural drying, artificial drying and mixed mode solar drying. Results showed that solar greenhouse drying system is the optimal technique that could apply for semi-dried jerky in Gia Lai province. This study presents a brief overview of literature and legal resources related to food quality and inexpensive drying methods that would be suitable for semi-dried jerky in Gialai province.

Keywords: *Drying technology, quality standards, semi-dried jerky, solar greenhouse drying*

1. Introduction

Jerky is one of the typical intermediate-moisture foods that has been cut into strips and dried (dehydrated) to prevent spoilage [1]. Before dehydrating process, salt is usually added to prevent bacteria growth. Modern manufactured jerky is often marinated, prepared with a seasoned spice rub or liquid, or smoked with low heat (usually under 70°C). Store-bought jerky commonly includes sweeteners such as brown sugar [2].

The drying process is the oldest and widely used preservation methods of foods due to highly efficient and inexpensive. The shelf-life of meat and meat products were extended because of the reduction in water activity [3, 4]. The microbial load was reduced after the drying process and volumes and weights of the products were also lighter, which decrease storage and transportation costs [5].

Semi-dried jerky is a famous product in Gialai province because its properties from beef meat, specialty, featured spice... However, a major problem associate with this product is that we have no appropriate techniques of meat preservation that are suitable for Gialai. The meat is smoked and dried mainly by the village human who are mostly illiterate and have no scientific knowledge about its quality [6, 7]. Obviously, their products do not meet the quality standards. There is no information on the physical and nutritional features of drying of beef in Gialai. Furthermore,

selecting the correct drying method is important step affecting the quality, time, and cost of dried food products. Therefore, the application and advances of different drying methods need to be considered.

This research is a part of a project that investigates the quality and develops a new solar dryer for semi-dried jerky in Gialai province.

This study reviewed (1) the present quality standards published by Vietnam Standards and Quality Institute (VSQI); (2) discuss some common drying methods that are suitable for semi-dried jerky. The considering methods were natural drying, artificial drying and mixed mode solar drying

2. Quality Standards for Semi-Dried Jerky

2.1. Definitions

Beef standards and grading are terms that require some definition for accurate discussion as, together with classification, they are often used interchangeably in discussing beef appearance, cuts, estimated yield and eating quality. Classification is defined as a set of descriptive terms describing features of beef that are useful to those involved in the trading. Generally, this involves ranking beef in a hierarchy for the traits of interest. Depending upon the country marbling and lean color and/or texture have often been included other measurements of fatness (internal fat scores, rib) or muscling (eye muscle area, or carcass conformation). These parameters remain relevant and are in use today in most beef grading schemes [8]. Although the standard and quality grades for beef has been published by government in most countries in the world, related report on semi-dried jerky is limited. Vietnam standards are based on nationally uniform standards of quality developed by VSQI. VSQI published that the standards for fresh meat are following TCVN 7046:2009 [9]. Before treating with sun drying, beef was mixed with food additives such as salt, sugar, pepper, chili, lemongrass, monosodium glutamate. Therefore, TCVN 9668:2017 for corned beef has been reviewed [10]. Although semi-dried jerky in Gialai has been treated by natural sun drying method, the rest part is dominant (> 5%) which has not yet treated by sun drying. Therefore, TCVN 9668:2017 is not suitable for semi-dried jerky. Additionally, the product was stored in cool or frozen condition after drying and packaging. The product should be applied the standard for frozen meat. Thus, TCVN 7047:2009 for frozen meat was reviewed [11].

3. Standards Review for Semi-Dried Jerky

3.1. Materials

Fresh meat from the cattle has to approve by the competent veterinary inspection agency for use as food.

3.2. Sensory Evaluation

Properties	Requirements
Visual observation	The meat surface is dry, clean, free from fur and impurity
	Smooth shear
	Elasticity, no fingerprint when pressing
	The marrow adheres to the medullary tube (option)
Color	Product feature
Smell	Product feature, no funky smell
Flavor	Product feature

Table 1. Sensory Evaluation

3.3. Physicochemical Evaluation

Properties	Requirement
pH	5.5 ~ 6.2
Qualitative reaction with hydro sulfua (H_2S)	Negative
Ammonia content, (mg/100g)	≤ 35

Table 2: Physicochemical Evaluation

3.4. Contaminated substances

3.4.1. Heavy Metal Content

Properties	Maximum (mg/kg)
Cadimi (Cd)	0.05
Lead (Pb)	0.1

Table 3: Heavy Metal Content

3.4.2. Hormone Residue

Properties	Maximum (mg/kg)
Dietylstylbestrol	0,0
Testosterol	0,015
Estadiol	0,0005
Beta-agonist group (Salbutanol and Clenbutanol)	Disallow

Table 4: Hormone Residue

3.4.3. Veterinary Drug Residue and Pesticide Residue

Veterinary drug is following 24/2013/TT-BYT circular (Appendix A) while pesticide residue is according to the 50/2016/TT-BYT circular (Appendix B) [12, 13].

3.5. Bacteria

Properties	Maximum (Colony forming unit CFU/g)
Aerobic bacteria	10^5
Coliform	10^2
E. coli	10^2
Staphytlococcus aureus	10^2
Clostridium perfringens	10^2
Salmonella (in 25g product)	Disallow

Table 5: Bacteria

3.6. Parasites

Properties	Requirement
Cysticercus csuitsae; Cysticercus bovis...	Disallow
Trichinella spiralis	

Table 6: Parasites

3. Drying Technology

3.1. Definitions

Drying is the oldest method of preserving food. Drying is applied to reduce the water content of products. Reducing the water content of products is purpose to prolong the shelf-life of bio-origin by reducing the water activity. At low water content, growth of microorganisms, enzymatic reactions, and other deteriorative reactions are inhibited [14, 15].

Basically, drying can be divided into two types: natural drying and artificial drying. Natural drying takes place under the influence of sunlight and wind. There is no control over temperature, air flow and humidity in natural drying. Artificial drying is the method which can control the condition of drying process. Artificial drying includes the methods drying by heated air, direct contact with heated surface, and application of energy from a radiating microwave or dielectric source [15-20].

3.2. Natural Drying

3.2.1. Sun Drying:

Drying the food product under natural sunny conditions is called as sun drying. This drying process is no required energy. Hot days are desirable with high temperature ($\geq 35℃$) and low humidity. However, problems of contamination and intermittent drying are generally encountered with sun drying. For sun drying, vegetables and meats are not recommended. Microorganism in meats will grow due to high protein when heat and humidity cannot be controlled [21-25].

Figure 1: Sun Drying Beef

Advantages	Disadvantages
No energy is required	Slow drying process
Cheap, simple	Time taking
Friendly to the environment	Molding of food may occur due to slow drying
	Cannot carried out in dust, rainy weather
	Contaminations from the environment
	Product losses and contaminations by insects and birds
	Floor space requirements
	Inconsistent sensory quality

Table 7: Advantages and Disadvantages of Sun Drying

3.3. Solar Drying

Solar drying also uses the sun as the heat source. It uses designed structures to collect and enhance solar radiation. There are two types of solar dryer [26, 27]:

+ Direct solar dryer: expose the substance to be dehydrated to direct sunlight.

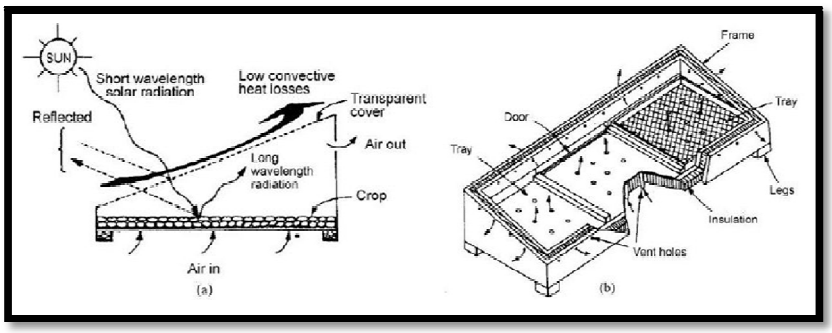

Figure 2: Working Principle of Direct Solar Dryer [28]

+ Indirect solar dryer: the sun shines upon a solar collector heating air which then moves upward through a stack of four to six trays loaded with produce. Indirect solar dryer is ideal for small scale due to low cost requirements and low throughput whereas the commercial drying requires high throughput

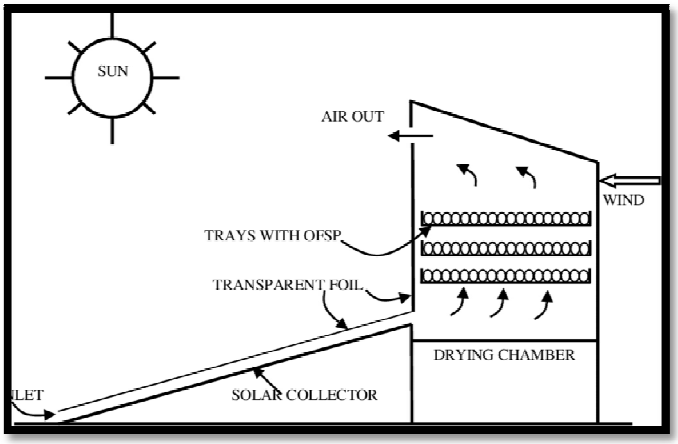

Figure 3: Indirect Solar Dryer [29]

Solar dryers consist of three main components: a drying chamber in which food is dried, a solar collector that heats the air, and airflow system. The drying chamber could protect the food from insects, dust, rain, and animals. The solar collector is made by a dark or black colored box with a transparent cover. The solar collector can heat the air temperature within 10 ~ 30℃ above ambient temperature. The airflow system can be natural convection or forced convection with fans. The forced convection can reduce the drying time and increase drying efficiency [29, 30]. The advantages and disadvantages of solar drying method are shown in Table 8 [31].

Advantages	Disadvantages
Drying is faster because inside the dryer it is warmer than outside	UV radiation can damage food
Less risk of spoilage	More complex and expensive than direct sun drying
The product is protected against flies, pests, rain and dust	Hot and dry climates preferred
Labour saving	Capacity per unit area of dryer is limited
The quality of the product is better in terms of nutrients, hygiene and colour	

Table 8: Advantages and Disadvantages of Solar Drying

4. Artificial Drying

4.1. Oven Drying

Air-oven drying is one of the most widely and commonly used methods. An oven is commonly combined the factors of heat, low humidity and air flow. The ovens should be thermally regulated to ± 0.5℃ and have minimal temperature variations (≤ 3℃ is better). The heat source is usually electric or infrared.

Figure 4: Beef Jerky in Oven Dryer

There is no temperature control feature for lowering the heat and the oven usually run at high temperature. Infrared is usually the best choice where a process requires high temperature and a lower capital expense. Infrared radiation causes rapid and direct heat concentration on the material compared to the electrical heat source [32, 33].

Advantages	Disadvantages
Accommodates large number of samples	Variations of temperature due to particle size, sample weight, position in the oven
Large sample volumes possible	Difficult to remove all water
High accuracy	Loss of volatile substances during drying
Attain the desired temperature more rapidly	Decomposition of sample (i.e., sugar)

Table 9: Advantages and Disadvantages of Oven Drying

4.2. Freeze Drying

Freeze drying is a low temperature dehydration process that involves freezing the food, the reducing the pressure and adding heat to allow the frozen water in the food to sublimate. Freeze drying occurs in three phases.

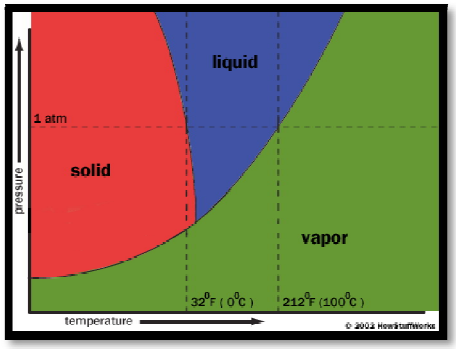

Figure 5: Phrase Diagram [34]

- Freeze phase: during the freeze phase, food is cooled below its triple point, the lowest temperature at which the solid, liquid and vapor phases of the food can coexist.
- Primary drying phase (sublimation): during the primary drying phase, the pressure is lowered and heat is added to the food in order for the water to sublimate. The structure of food could be altered if too much heat is added. About 95% of the water is sublimated.
- Secondary drying phase (adsorption): the final phase is secondary drying, during which the ionically-bound water molecules are removed. The temperature is raised higher than in the primary drying phase to break the bonds between food and water molecules.

Advantages	Disadvantages
Shelf-life extension	Spoilage organisms and pathogens resistant to the low temperature dehydration process can remain
Nutrients are retained and color is maintained	High cost
Easy storage	The product is prone to oxidation, due to high porosity and large surface area

Table 10: Advantages and Disadvantages of Freeze Drying

5. Mixed Mode Solar Drying

5.1. Passive Mode

The passive mode solar dryer is due to natural circulation. It is similar with indirect solar dryer. However, to minimize heat losses from the back of the solar collector, an insulation layer is installed at the bottom of the collector.

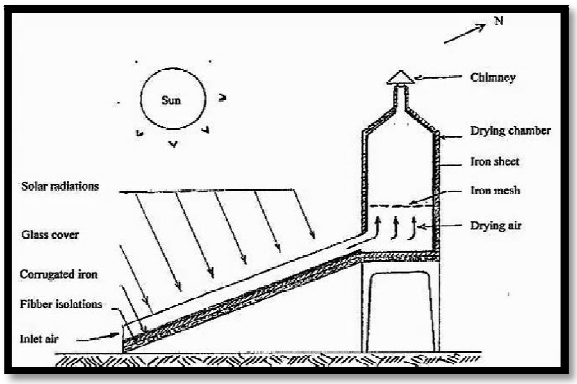

Figure 6: Passive Solar Dryer [35]

5.2. Active Mode

In this mode of mixed solar dryers, a blower or fan is installed to force the air into or out of the drying chamber. Solar dryer with green house is commonly used. Green house made from glass, plastic film, poly film or polycarbonate plate is often used as a collector. Heat air is forced to pass through the drying trays with an exhaust fan.

Figure 7: Active Solar Dryer [36]

6. Conclusions

This paper discussed various types of drying methodologies. Among the advantages of a greenhouse dryer are simple structure, large load capacity and relatively good thermal performance. We concluded that greenhouse dryer is most suited for semi-dried jerky in Gialai province, Vietnam.

Furthermore, standardization is an important criterion for assessing the progress made by Vietnam in the integration process to the worldwide. Although the compliance with standards is not mandatory (the standards are not laws but rules, guidelines and characteristics for activities and their results), we hope that the products "in compliance" have the best quality while delivering to the consumers.

7. Acknowledgement

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Appendix

No.	Property	ADI (µg/kg Bodyweight/Day)	Ingredients	MRL (µg/kg)
1	Albendazole (Anthelmintic)	0-50	2-aminosulfone metabolite	100
2	Amoxicillin (Antibacterial drug)	0-0.07	Amoxicillin	50
3	Benzylpenicillin Procaine benzylpenicillin (Antibacterial drug)	30	Benzylpenicillin	50
4	Ceftiofur (Antibacterial drug)	0-50	Desfuroylceftiofur	1000
5	Chlortetracycline Oxytetracycline Tetracycline (Antibacterial drug)	0-30	Main ingredients, individual ingredient and combined ingredient	200
6	Clenbuterol (Sympathomimetic drugs – adrenoceptor)	0-0.004	Clenbuterol	0.2
7	Closantel (Anthelmintic)	0-30	Closantel	1000
8	Colistin (Antibacterial drug)	0-7	Total Colistin A and Colistin B	150
9	Cyfluthrin (Insecticide)	0-20	Cyfluthrin	20
10	Cyhalothrin (Insecticide)	0-5	Cyhalothrin	20
11	Cypermethrin Alpha-cypermethrin (Insecticide)	0-20	Total cypermethrin residual	50
12	Danofloxacin (Antibacterial drug)	0-20	Danofloxacin	200
13	Deltamethrin (Insecticide)	0-10	Deltamethrin	30
14	Dexamethasone (Glucocorticosteroid)	0-0.015	Dexamethasone	1
15	Dihydrostreptomycin Streptomycin (Antibacterial drug)	0-50	Sum of dihydrostreptomycin and streptomycin	600
16	Diminazene (Drug treatment of blood parasites)	0-100	Diminazene	500
17	Doramectin (Anthelmintic)	0-1	Doramectin	10
18	Eprinomectin (Anthelmintic)	0-10	Eprinomectin B1a	100
19	Febantel Fenbendazole Oxfendazole (Anthelmintic)	0-7	Sum of fenbendazole, oxfendazole and oxfendazole sulphone	100
20	Fluazuron (Insecticide)	0-40	Fluazuron	200
21	Flumequine (Antibacterial drug)	0-30	Flumequine	500
22	Gentamicin (Antibacterial drug)	0-20	Gentamicin	100
23	Isometamidium (Drug treatment of blood parasites)	0-100	Isometamidium	100
24	Levamisole (Anthelmintic)	0-6	Levamisole	10

No.	Property	ADI (µg/kg Bodyweight/Day)	Ingredients	MRL (µg/kg)
25	Monensin (Antibacterial drug)	0-10	Monensin	10
26	Moxidectin (Anthelmintic)	0-2	Moxidectin	20
27	Narasin (Antibacterial drug)	0-5	Narasin A	15
28	Neomycin (Antibacterial drug)	0-60	Neomycin	500
29	Pirlimycin (Antibacterial drug)	0-8	Pirlimycin	100
30	Ractopamine (Growth stimulant drugs)	0-1	Ractopamine	10
31	Spectinomycin (Antibacterial drug)	0-40	Spectinomycin	500
32	Spiramycin (Antibacterial drug)	0-50	Sum of spiramycin and neospiramycin	200
33	Thiabendazole (Anthelmintic)	0-100	Sum of thiabendazole and 5-hydroxythiabendazole	100
34	Tilmicosin (Antibacterial drug)	0-40	Tilmicosin	100
35	Trenbolone acetate (Growth stimulant drugs)	0-0.02	Beta-trenbolone	2
36	Triclabendazole (Anthelmintic)	0-3	Ketotriclabendazole	250
37	Tylosin (Antibacterial drug)	0-30	Tylosin A	100
38	Zeranol (Growth stimulant drugs)	0-0.5	Zeranol	2

Table 11: Maximum Veterinary Drug in Beef Meat