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Solutions for Managing Tomato Culls in Florida Tomato Packinghouses[1]

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Introduction and Purpose

Florida is the single largest producer of fresh-market tomatoes in the United States. Driven by urbanization and generation of large amounts of tomato culls, tomato packers in Florida often struggle to find ways to dispose of culls generated during the cleaning and sanitizing of tomatoes. The high transportation costs for off-site disposal is the most critical issue associated with the management of culls in Florida tomato packinghouses. Approximately 70 tomato packinghouses in Florida pack tomatoes for the domestic market and generate 150,000–400,000 tons (1 ton = 907 kg) of culls each year.

The purpose of this article is to provide guidelines for appropriate management practices to increase the use of culls produced in tomato packinghouses in Florida. Our recommended practices in this article should be modified as science and knowledge provide additional data to manage culls in tomato packinghouses.

Tomato Production Trends in the United States

Tomato is one of the important vegetables consumed in the United States. For example, in 2007, about 1.87 billion kg of fresh-market tomato were produced for domestic use in the US (VanSickle and Hodges, 2008). Of this quantity, more than 81% of tomatoes were grown in the southeastern states (Alabama, Florida, Georgia, North Carolina, South Carolina, Tennessee, and Virginia) and California. Florida is the largest producer of field-grown, fresh-market tomato (650 million kg or 34% of total US production) with a total value of $464 million. An estimated 90% of Florida tomatoes are shipped out of state to the eastern US and Canada (VanSickle and Hodges, 2008). Since 1991, Florida has lost market share of tomato production to other US producers such as California (**Figure 1**). However, imports from other countries, such as Mexico, have taken a greater share of the market from Florida producers than domestic competitors.

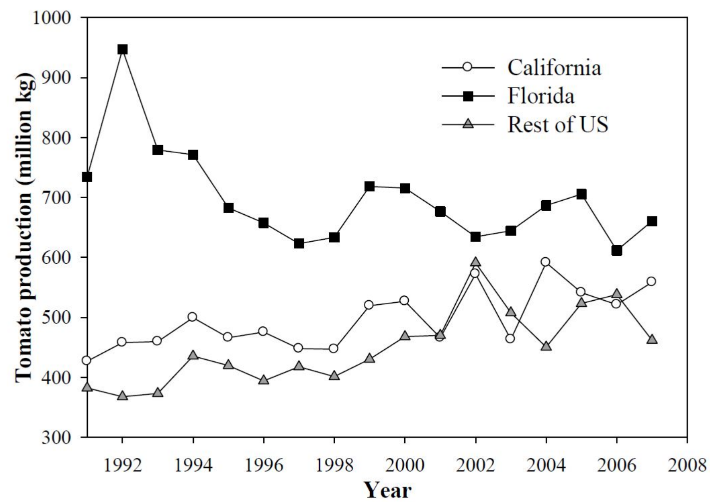

Figure 1. Amounts of tomatoes produced in Florida, California, and rest of US, 1992–2008
Credits: VanSickle and Hodges, 2008

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A survey conducted in Florida (Sargent, 2007) indicated that 60%–80% of the total tomato volume is packed in four production districts of Florida (**Table 1**). Based on this information, the estimated amounts of culls range from 150,000 to 400,000 tons (equivalent to 20%–40% of the total tomato production).

Potential of Tomato Culls for Composting

Land application of organic wastes is an acceptable method of recycling nutrients that plants take up from the soil, provided to animals as feed, and then returned to the soil as manure. Composting of organic wastes is a microbial decomposition process that produces CO_2, water, mineral ions, and stabilized organic matter. The composting process facilitates handling by lowering the volume of waste to be transported, lowers transportation costs, reduces particle size allowing for uniform field application, stabilizes nutrients, and decreases phytotoxic substances, such as high concentrations of ammonia.

An option for disposal of vegetable waste that is non-edible and discarded during collection, handling, transportation, and processing can be composting. Composts can improve soil chemical and physical properties, act as surface mulches, increase organic matter, suppress weeds, and improve water holding capacity as well as provide nutrients. Compost is not traditionally considered a fertilizer because most of the nutrients present in compost are not immediately available, but are released at a slow rate.

In 1997, USDA reported that 10 million tons of tomato were processed in the US, of which 1–3 million tons were not used for human consumption. Typically, packinghouses apply vegetable waste to land, feed it to livestock, ship it to landfills, or pile it near the packinghouses for decomposition. The costs of landfills and concerns about solid wastes have increased interest in finding a new economical outlet for tomato by-products. Composting provides a safe disposal method for the waste produced each year. Compost can be used as a means of reducing the frequency and rate of irrigation and inorganic fertilizer used on Florida sandy soils, increase organic matter, promote soil aggregation, and increase yields. We investigated whether tomato could be composted and then evaluated the effects of tomato cull-based growing mixes on bell pepper (*Capsicum annuum*) growth and development.

Tests were conducted to compare the growth of bell peppers in composted media using fresh tomato culls, which were shredded using a conventional wood shredder. The tomato cull fruit were shredded along with pine bark (¾ to 1 inch in diameter) to produce the following mixed growing media combinations: (a) 50% fine-grade pine bark + 50% shredded tomato culls (1:1 v/v); and (b) 33% fine-grade pine bark + 67% shredded tomato culls (1:2 v/v). For comparison purposes, a 100% pine bark medium served as the control. Each medium was produced 4 weeks before transplanting. Black plastic pots (7.5 L) were filled with media and were distributed in a completely randomized design with four replications. Each replication consisted of 50 'Aristotle' bell pepper plants. During the study, bell pepper plant height and leaf nutrient analysis at 4 weeks after transplanting and marketable fruit weight were collected through four harvests.

There were no differences in plant height and marketable fruit weight, regardless of the chosen medium. Bell pepper plant height at 4 weeks after transplanting ranged between 38 and 46 cm. Average cumulative fruit weight was 5.3 kg/plant. There were differences in the foliar concentrations of P, Ca, Mg, Mn, Zn, and B, with the highest concentrations occurring in bell pepper plants established in the two media containing shredded tomato culls. The shredded tomato culls could partially replace pine bark as a soilless medium for producing bell pepper in greenhouse conditions. The increase in the concentration of certain nutrients in the foliage of bell pepper could be attributed to the contribution of shredded tomato culls. The results suggest that tomato culls could be successfully composted and used as a component of media for growing other vegetable crops in greenhouse conditions. However, field-scale studies should address the potential of this media as a nutritional soil amendment. Economic aspects will dictate the feasibility of this procedure, and, therefore, a cost-benefit analysis of composting culls vs. currently used approach of land disposal is recommended.

There are, however, some concerns about contamination of the next tomato crop with human pathogens such as *Salmonella*. The potential vectors (suspects) that can contaminate tomato plants with *Salmonella* are irrigation water, soil, animal waste, and insects (Brandl, 2006). Barak and Liang (2008) investigated the role of soil and crop debris in contaminating tomato plants with *Salmonella enterica*. In first study, they irrigated soil with *S. enterica* contaminated water and observed that *S. enterica* survived in fallow soil for six weeks following irrigation. In a second study to investigate the persistence of *S. enterica* in fields used for continuous tomato cropping, they produced a contaminated tomato crop, which was then mulched and mixed with soil. Then tomato seeds were sown in the mixture either 1 day or 7 days later. They found that when seeds were sown 1 day later, *S. enterica* was recovered from the phyllosphere (above-ground plant parts such as leaf surfaces) and the rhizoplane (below-ground plant parts as in the external surfaces of roots). However, at the 3–5 leaf stage, *S. enterica* population in the phyllosphere was below the detection level. When seeds were sown 7 days later, *S. enterica* was not recovered from the phyllosphere. These results may mean that if there is at least 7 days fallow period after incorporation of fresh culls contaminated with *S. enterica*, there is a minimum risk of contamination of next tomato crop. While it is likely that well-managed composting of culls may further decrease the incidence of *S. enterica* transmission to the next tomato crop, however, more research is needed on this subject.

Potential of Tomato Culls for Animal Feed

Food wastes can be used as an alternative animal feed, a practice that in turn can reduce the cost of animal production and provide public and environmental benefits. Not only is it economical and environmentally beneficial, the sale of the byproducts (waste) or co-products (waste mixed with other components) can generate additional revenue. For example, a livestock farmer can reduce costs and save money if a byproduct is offered that is a less expensive source of nutrients than traditional feed.

More traditional components being used in feed are hay, wheat straw, wheat grain, brewer's grain, and soybean meal. Byproducts and material from the food processing industry are often included in animal feed and livestock diets; however, some byproducts are not used consistently due to uncertainty of availability, handling characteristics, nutrient composition, and palatability. Pepper, tomato pulp, artichoke, and apple pomace have been studied for their potential use as feed constituents for ewes. Cane molasses is widely used as an additive in cattle feed, hailed for stimulating the intake of other feeds as well as being palatable and inexpensive. Dried citrus pulp has been fed successfully to dairy and beef cattle as well as sheep, and more than 90% of the dried citrus pulp fed to animals in the US is fed to lactating cows.

Vegetable waste is high in digestibility and moisture, and can be used as a replacement in feed for dairy cows without affecting growth or milk production. Tomatoes have become an important vegetable due to its use in culinary preparations, but increased consumption has in turn caused increased volumes of waste such as skin, fibrous matter, and culls. Using byproducts such as tomato waste as a source of animal feed can be a valuable source of energy and nutrients to feed ruminants.

Tomatoes have high moisture, which limits the amount of time it can be stored, therefore tomato waste is often dried. Tomato waste seeds and seed meal were found to have high lysine content that could improve the protein quality of cereal products. Studies have shown that high amounts of nutrients, crude protein (25%), and dietary fiber (34%) are present in tomato seeds, so the inclusion of tomato seeds in poultry diets can improve weight gain. Tomatoes can be a potentially good source of crude protein and crude fiber in animal diets. However, because of the high water content of tomato fruits, they must be dehydrated or mixed with other byproducts to be useable. With increased concerns about food safety, the potential of culls to be a source of pathogens may limit their use as a feed source.

Tomato culls can be dried, dehydrated, or prepared in a way that is suitable as an animal feed source. Dried tomato pulp has high fiber, which could be used in poultry diets at a low rate as an alternative to cereal. The dried pulp can be included in the poultry diet at 50 g/kg without any adverse effects on performance. We investigated the scope of a procedure to dry tomato culls.

A Recommended Procedure for Drying Tomato Culls

As no guidance was available in the literature on optimal ways to dry tomato culls, we explored selected temperature regimes for several time periods in an effort to standardize the drying approach. For this purpose, two types of tomato (green and red) were collected and subjected to different range of temperature and time regimes to determine the best drying strategy. Temperature conditions were varied from 150°C to 300°C in a temperature controlled muffle furnace for different time periods. Beyond 300°C, the tomatoes samples were totally burnt. In each temperature regime, tomato culls were uniformly chopped into equal sized pieces and spread in a single layer. A total of nine different temperature regimes at different time periods were tested. The end point for the drying of tomatoes was assumed to be neither too dry (resulting in a very hard and indigestible product) nor too moist (capable of supporting bacterial and fungal growth during storage). Visual observation was one of the criteria for obtaining the required results. Holding time at each temperature played a significant role in drying the culls. Based on these preliminary trials, the best temperature and duration regime was found to be 150°C for 30 minutes, followed by 175°C for 30 minutes, and 150°C for 60 minutes. The moisture loss observed in this treatment regime was approximately 70%. After these oven-dried samples were kept for two days at room temperature, a further moisture loss (21%–23%) was observed, resulting in total moisture loss of 91%–93%. This suggests that tomatoes can be dried using this procedure. However, a cost-benefit analysis including energy requirement to dry tomatoes is needed to compare this practice to the currently used land disposal practice.

References

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Table 1. Amount of tomato culls produced in Florida (1 ton = 907 kg). Source: Sargent, 2007.

Production District	**Total Packout**	**80% Packout**		**70% Packout**		**60% Packout**	
		Total Received (packout + culls, tons)	Total Culls (20%, tons)	Total Received (packout + culls, tons)	Total Culls (30%, tons)	Total Received (packout + culls, tons)	Total Culls (40%, tons)
1	52,522	65,653	13,131	75,032	22,510	87,537	35,015
2	52,985	66,231	13,246	75,693	22,708	88,308	35,323
3	169,897	212,371	42,474	242,710	72,813	283,162	113,265
4	323,099	403,874	80,775	461,570	138,471	538,499	215,400
State total*	598,504	748,130	149,626	855,005	256,502	997,506	399,003

*State total does not include production in the non-regulated area west of the Suwannee River, the Quincy area.