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Fresh grocery produce as a supplement for livestock feed: Nutrient composition and aerobic stability[1]

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ABSTRACT

Nutrient content and aerobic stability of fresh grocery produce was assessed in March (Exp. 1) and September (Exp. 2) of 2015 from retail stores located in the Raleigh, North Carolina, area. Five stores were sampled at each time. Nutrient content data were analyzed using Univariate procedures of SAS, and aerobic stability data were analyzed using the Mixed procedure of SAS. Fresh grocery produce had a high moisture concentration (DM = 9.1 ± 1.35%) and a TDN of 76.1 ± 5.94%. The CP, sugar, and starch concentrations averaged 17.2 ± 3.76%, 35.8 ± 6.44%, and 2.3 ± 0.91%, respectively. Total fat averaged 4.7 ± 2.9% and was composed mainly of linoleic and oleic fatty acids. Neutral detergent fiber and ADF averaged 16.8 ± 1.75% and 13.6 ± 1.96%, respectively. Glutamic and aspartic acids comprised the largest amino acid fraction (2.0 ± 0.09% and 1.7 ± 0.08%, respectively). In Exp. 2, the CP (13%) and sugar (12.9%) concentrations were less and the DM (11.4%) and starch (21.7%) concentrations greater when compared with Exp. 1. Aerobic storage, ensiling, of fresh grocery produce reduced pH and increased lactic acid but not significantly ($P > 0.10$). Acetate increased ($P < 0.01$) by d 5 but decreased ($P < 0.01$) by d 12 of aerobic storage. Fresh grocery produce can be a good source of nutrients for livestock; however, the inherent variability in nutrients and the high moisture concentration are factors that require further consideration for it to be a viable option for farmers to include as a feed supplement.

Key words: food waste, grocery produce, aerobic stability, livestock feed

INTRODUCTION

The fact that almost a third of the annual food produced in the United States is not consumed by humans has drawn wide attention in recent years (Foley, 2011). Typically, 97% of wasted food is disposed in landfills (EPA, 2015; EPA, 2016a,b). The use of food waste as animal feed is one partial solution to this problem, and it represents the highest nonhuman food strategy on the Environmental Protection Agency's (**EPA**) food recovery hierarchy (EPA, 2016b). At the same time, in response to the Food Safety Modernization Act, the US Food and Drug Administration has published a set of rules describing how animal feed manufacturers must demonstrate good hygiene, proper process controls, sanitation principles, and labeling of ingredients and finished products. To satisfy the goals of both the EPA and the US Food and Drug Administration, scientific data on the quality and safety of food waste as animal feed is at a premium.

Grocery stores in the United States generate significant amounts of food scraps from trimmings and other excess product that has deteriorated beyond saleable quality for human consumption. Food scraps consist of portions of produce that have become unwholesome due to deterioration, discoloration, or general loss of freshness. Historically, much of this excess organic material has been discarded into landfills (BSR, 2014). However, the environmental costs of this practice (Venkat, 2012) have prompted most grocery chains to adopt more sustainable practices for at least 2 reasons: as a matter of social responsibility and in response to customer demand. Practices such as composting and industrial conversion to energy via anaerobic digestion are considered superior to landfills according to the EPA hierarchy. However, composting generally results in a net cost to retailers, and anaerobic digestion is currently not available in most areas. Using produce and bakery waste as animal feed recovers the energy in the food and potentially raises the value of the postretail supply chain, especially if the nutritional quality and safety of the waste can be maintained through efficient handling.

We conducted 2 experiments to evaluate the nutritional quality and aerobic stability of produce waste in the postretail environment. To compare seasonal variation in nutrient concentration, Exp. 1 was conducted in March 2015 and Exp. 2 was conducted in September 2015. Aerobic stability was assessed in Exp. 2.

[1]Use of trade names in this publication does not imply endorsement by the North Carolina Agricultural Research Service or criticism of similar products not mentioned.
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MATERIALS AND METHODS

Exp. 1: Comparative Assessment of Nutrient Profile

Fresh grocery produce (**FGP**) was collected from 5 different store locations in the Raleigh area, placed in 114-L plastic totes with lids, and transported to the Animal and Poultry Waste Management Center at North Carolina State University. Each plastic tote represented a single store location, and all 5 totes were stored for 4 d in walk-in coolers (4°C). After 4 d of storage, the entire FGP sample within the tote was processed separately into a semi-homogeneous slurry using a large grinder (Buffalo 78 BG, Buffalo, NY) with a 0.5-cm metal die. Upon visual inspection, processed FGP consisted mainly of fine particulate in liquid suspension (80%) and a larger particulate fraction (20%). The FGP from each location was mixed manually, and an aliquot (~3 kg) was transferred into plastic bottles with screw caps and stored at −80°F. The frozen FGP samples were packed in dry ice and shipped to a commercial laboratory for nutrient analysis. The ingredients contained in the FGP samples consisted mainly of vegetables and fruits. The FGP samples were analyzed by a commercial laboratory (Cumberland Valley Analytical, Hagerstown, MD). Dry matter, CP, ADF, ash, minerals, and fat were analyzed according to procedures outlined by AOAC International (2000). Lignin concentration was determined as outlined by Goering and Van Soest (1970). Neutral detergent fiber and ADF was analyzed according to the procedure by Van Soest et al. (1991), and sugar and starch concentration were determined according to the procedures by Dubois et al. (1956) and Hall (2009), respectively.

Exp. 2: Effect of Grinding and Storage on Aerobic Stability

Experiment 2 was conducted in September 2016. Fresh grocery produce waste was collected from 5 Raleigh area grocery stores and transported to the Animal and Poultry Waste Management Center at North Carolina State University. The food waste from each store contained a mixture of over 20 different ingredients that included mainly fruits and vegetables. The FGP sample from each location was divided into 2 subsamples. One subsample was left unprocessed, and one subsample was processed. The unprocessed samples were placed back into their respective 114-L totes with lids. The other subsample was processed, as described in Exp. 1, thoroughly mixed by hand, and stored in 19-L buckets with lids. The processed sample was a mixture of liquid slurry and particulate matter similar to samples in Exp. 1. The unprocessed FGP and the processed FGP samples were placed inside a large walk-in metal housing located outside on a concrete pad. The housing was enclosed at the top and on 2 sides with a metal grid on the 2 ends to provide protection from rain and scavengers but allow exposure to air and ambient temperature. Three temperature probes (Spectrum Technologies Inc., Aurora, IL, Model 3667–20) were connected

Table 1. List of ingredients represented in fresh grocery produce samples (Exp. 1 and Exp. 2)[1]

Commodities represented in Exp. 1	Commodities represented in Exp. 2	Commodities represented in Exp. 1 and 2
Cilantro	Anise	Apples
Green beans	Avocado	Broccoli
Green onions	Bananas	Cabbage
Leeks	Beets	Cantaloupe
Lemons	Corn husks	Carrots
Limes	Cucumbers	Celery
Oranges	Jicama	Collard greens
Pears	Onions	Corn
Squash, acorn	Papaya	Eggplant
Squash, spaghetti	Peppers, chili	Grapes
	Peppers, jalapeno	Lettuce
	Pineapple	Mushrooms
	Potatoes	Mustard greens
	Raspberries	Parsley
	Squash, yellow summer	Peaches
	Squash, zucchini	Peppers, bell
	Sweet potatoes	Plums
	Watermelon	Spinach
		Strawberries
		Tomatoes

[1]n = 5 for Exp. 1 and Exp. 2.

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