Acid Whey pH and Nutrient Content

Acid whey (AW) is a co-product from the production of Greek yogurt, cottage cheese and cream cheese. In general, three of every four pounds of milk used in Greek yogurt production become acid whey. Often, acid whey is used as a feed source for cows, directly land-applied, co-digested with manure, or added to manure in storage structures on farms. Acid whey contains nitrogen (N), phosphorus (P) and potassium (K) and other nutrients that can benefit crops. On dairy and livestock farms, the importation of acid whey should be considered carefully to make sure the additional nutrients will meet short- and long-term goals and that the nutrients can be recycled to meet crop needs. In this factsheet, we present pH and nutrient composition of acid whey from a limited set of processing facilities in New York.

pH

The name acid whey reflects the low pH of the whey, typically ranging from 3.6-4.5 with an average value of 4.1 (Table 1). Sweet whey, a co-product from the production of hard cheeses, often has a pH of 5.6 or higher, by comparison. At a rate of 10,000 to 20,000 gallons/acre, land-application of acid whey first results in a rapid decrease of soil pH, quickly followed by a sharp increase to levels higher than the initial soil pH and then a gradual decline. This swing in soil pH can be as large as 2 pH units and may last for 1-4 weeks. In acid soils, the pH eventually settles at a level below the starting pH before application, creating a net pH decrease. In the long-term acid whey addition to already acid soils will increase lime requirements for optimal crop production. For well-buffered, high pH soils, applications at a rate of 10,000 to 20,000 gallons/acre will still cause a pH swing but the applications will not impact the final soil pH.

Solids and organic matter

Acid whey is mostly water with 2.5 to 6.5% solids, averaging 5.2% (Table 1). Solids can impact infiltration with more rapid soil infiltration when the percent solids is low. Given the same solids content, acid whey infiltrates faster than manure (see Factsheet #97).

Chloride

The chloride (Cl) content of AW ranges from 6.6 to 15.8 lbs/1000 gallon with an average value of 9.3 lbs/1000 gallons. New York State (NYS) law prohibits chloride application in excess of 170 lbs Cl/acre per year (NYS Department of Environmental Conservation Part 360). Chloride applied at high rates may inhibit seed germination and a plant's ability to uptake water. At the average value of 9.3 lbs Cl/1000 gallons, the annual maximum Cl application rate is triggered at just over 18,000 gallon/acre. This example upper limit rate will be used to illustrate application rates of other nutrients throughout this fact sheet. The wide range in Cl in the samples analyzed (Table 1) suggests that whey sources should be tested regularly to determine the allowable rate for direct land application. When mixed with manure, the Cl content of the manure-acid whey mixture will be lower.

Nitrogen

Nitrogen in the acid whey samples tested was primarily in organic-nitrogen form and varied considerably across samples with a range of 1.9 to 21.6 lbs/1000 gallons and an average of 7.1 lbs/1000 gallons (Table 1). At the average N value, an application rate of 18,000 gallons/acre supplies about 130 lbs of total N/acre. Not all this N will be plant available, but users should credit a portion of the organic N in the crop year in which the whey is applied. The availability of organic N in acid whey has not been evaluated, but using manure as an example, 35% of the organic N is typically credited for the crop year in which manure is applied. Additional research is needed to determine if N release from the organic N in whey is different from N release from manure.

Phosphorus

Acid whey supplies P, expressed as P_2O_5 (fertilizer equivalent), with content ranging from 10.1 to 16.2 lbs/1000 gallons, averaging 14.1 lbs P_2O_5 /1000 gallons (Table 1). At this average value, an 18,000 gallons/acre application rate supplies about 250 lbs of P_2O_5.

Table 1. Composition of acid whey from three processing facilities in New York State.

	Unit	N	Minimum	Maximum	Median	Average	Standard deviation
pH		36	3.55	4.48	4.22	4.11	0.31
Solids	%	52	2.49	6.53	5.72	5.16	1.24
Total nitrogen	lbs/1000 gallons	52	1.87	21.56	4.64	7.10	6.47
Ammonia-N	lbs/1000 gallons	52	0.00	1.34	0.00	0.23	0.42
Organic-N	lbs/1000 gallons	52	1.58	21.56	4.59	6.87	6.32
Phosphorus as P_2O_5	lbs/1000 gallons	52	10.06	16.19	14.20	14.11	1.03
Potassium as K_2O	lbs/1000 gallons	52	11.89	17.73	16.22	16.09	1.08
Calcium	lbs/1000 gallons	52	7.57	11.42	10.19	10.15	0.72
Magnesium	lbs/1000 gallons	52	0.59	0.94	0.84	0.83	0.07
Sodium	lbs/1000 gallons	52	2.61	3.68	3.26	3.28	0.21
Sulfur	lbs/1000 gallons	48	0.42	1.42	0.51	0.61	0.28
Zinc	lbs/1000 gallons	48	0.03	0.04	0.03	0.03	0.00
Chloride	lbs/1000 gallons	25	6.59	15.77	9.01	9.25	1.84

A corn silage crop will typically take up about 4 lbs of P_2O_5 per ton of silage (at 35% dry matter). Thus, a 30 tons/acre corn silage crop removes about half of the amount of P_2O_5 supplied by an 18,000 gallons/acre acid whey application. For this reason, use of acid whey needs to be combined with monitoring of soil test P levels over time to manage P buildup and potential runoff losses.

Potassium

The potassium as K_2O content of acid whey ranged from 11.9 to 17.7 lbs/1,000 gallons with an average value of 16.1 lbs/1000 gallons (Table 1). At the average value, an application of 18,000 gallons/acre will supply nearly 300 lbs/acre of K_2O. Thus, if acid whey is applied at this maximum rate, it will supply more than what is annually removed with harvest of crops like corn or alfalfa. It is recommended to check if forages harvested from whey-amended fields are high in K, to avoid feeding such forages to dry cows.

Calcium, Magnesium and Sulfur

The average calcium, magnesium and sulfur content for the sources tested were 10.2, 0.8 and 0.6 lbs/1000 gallons, respectively (Table 1). At the average values, an application of 18,000 gallons/acre supplies 182 lbs of calcium, 15 lbs of magnesium, and 11 lbs of sulfur.

Sodium and Micronutrients

Acid whey averaged 3.3 lbs of sodium per 1000 gallons (Table 1). The sodium content is unlikely to cause problems given rainfall patterns in New York. Acid whey also contains small amounts of boron, iron, manganese and copper, which can benefit crops.

Summary

Acid whey contains a significant quantity of several important elements and can be used as a source of plant nutrients. Nitrogen and chloride content are most variable but content of other nutrients can vary as well. Acid whey needs to be tested to determine application rates to match crop needs and so that regulatory limits are not exceeded. Farms that are already nutrient dense (high animal density and no manure or crop export) may not be the best place for acid whey. For those farms, import of acid whey may contribute to unnecessary nutrient loss when crops are not able to satisfactorily recycle the extra nutrients.

Additional Resource

- New York Solid Waste Management Part 360: www.dec.ny.gov/regulations/81768.html)

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of particular discharge levels from agricultural land.

For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.cals.cornell.edu

Sanjay Gami, Greg Godwin, Karl Czymmek, Kevin Ganoe, and Quirine Ketterings

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