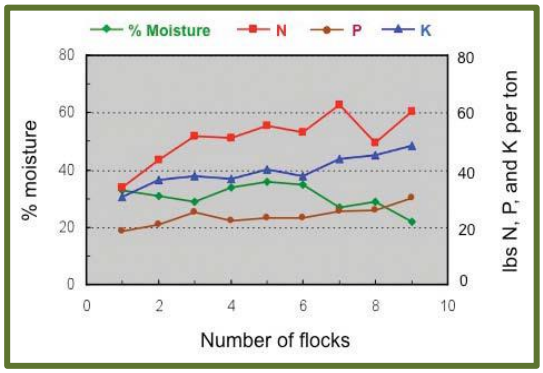
enviraPAC Biomass AG-Carbon® Granules for Poultry Operations & Litter Management

The poultry industry has been in search of more efficient and effective methods of managing broiler operations litter waste as well as reducing the formation of ammonia waste water runoff. Any agriculture or livestock operation will need to manage chemical run-off from various processes and develop solutions to reduce the adverse environmental footprint; this is where biomass carbon granules are a viable option to consider. Poultry litter (PL) management activities' main focus of keeping litter relatively dry is a critical part of overall litter management at every poultry operation from a small number of houses to large corporate facilities. Poultry litter (PL) composition is directly related to overall health of any bird breed and the more efficient the control of hazardous elements can be accomplished, the higher the quality of poultry produced.

Typical poultry litter makeup, as depicted in Exhibit A, is comprised of feathers, manure, and bedding which may include any combination of rice hulls, wood shavings, and straw. Specific elements in litter composition which require a continued concerted effort to control are moisture (H_2O), ammonia (NH_3) formation, and phosphorus (P) management. Multiple research studies have been completed over the years by various universities including the Department of Agriculture & Biological Engineering; Mississippi State University, Agriculture & Life Sciences Lincoln University – New Zealand, University of Georgia – College of Agriculture & Environmental Sciences. Additionally, one important study from the University of Arkansas analyzed poultry litter composition to observe the levels of the specific elements and nutrients (P, N, K) and the methods available to control, reduce, or manage the litter element makeup to meet state and local legislative initiatives[1]. Poultry litter (PL) - P,N,K levels are also directly related to the number of birds / flock contributing to the volume of litter. In Exhibit: B shows the relationship between the number of flocks and P,N,K nutrients.

Exhibit: A[2]

Exhibit: B[3]



[1] University of Arkansas, United States Department of Agriculture, and County Governments Cooperating; FSA9529 Nutrient Analysis of Poultry Litter
[2] University of Arkansas, United States Department of Agriculture, and County Governments Cooperating; FSA9529 Nutrient Analysis of Poultry Litter
[3] University of Arkansas, United States Department of Agriculture, and County Governments Cooperating; FSA9529 Nutrient Analysis of Poultry Litter

There are many factors that can affect the health and viability of poultry including ammonia levels, litter moisture levels, house ventilation, feed conversion, and litter caking[4]. Over the past two decades, the approach to poultry litter (PL) management has evolved to incorporate natural or biomass alternatives to manage key issues, with biochar the preferred control organic media. These key issues / elements include ammonia control, moisture control, and phosphorus content levels; all of which are detrimental and harmful to poultry yield efficiencies as well as the surrounding environment. Various litter management solutions, also called litter amendments, have been or are being used / evaluated including pine shavings, liquid alum, and mass-produced biochar. Application of poultry litter (PL) as a soil fertilizer amendment, may lead to nitrogen (N) losses through ammonia (NH_3) volatilization and from potential groundwater contamination from surface runoff. Concerted efforts are made in poultry litter (PL) control to achieve the goal of reducing litter moisture to target levels of 20% to 30% as higher levels directly contribute to higher concentrations or formation of ammonia (NH_3) and water soluble ammonia (NH_4)[5].

An increasing number of livestock / poultry operations are exploring the use of biomass carbons in animal waste / nutrient management practices. To further meet anticipated demand for biomass carbons, enviraPAC produces commercially available biomass carbon granules (non-activated) as a viable and prudent management tool which are higher in performance (sorption), higher purity (> 92% FC) than traditional biochar with unique characteristics including high BET (≥ 420 m^2/g). EnviraPAC carbon granules are not graphitic, yet possess a bulky, anisotropic morphology with high resiliency and strength ideal for long term use in livestock production or operations. *EnviraPAC BIO AG-Carbon® Granules*, a high quality biomass carbon ideal for poultry litter management, is produced utilizing a $C0_2$ neutral, auto-thermic technology which converts the biomass (Southern Yellow Pine chips) into high purity carbon (C) with ash values ranging from 4.5% to ≤1.75%, very low Sulphur content of < 0.05%, and low moisture content of < 2.0%.

Moisture content in enviraPAC Carbon Granules is controlled through an inert gas, post carbonization, closed loop system. EnviraPAC carbon granules are anisotropic morphologically with a dense particle structure displaying a propensity for a consistent / uniform high surface area (> 426 m^2/g BET) and high IAN (>270 g/kg). The higher than average BET compared to other carbon biochars is a result of high level of micro-porosity within the carbon particle. The photos below (*Exhibit C*) of *enviraPAC's BIO AG-Carbon® Granules* show the granule morphology which translates into easy incorporation into poultry bedding applied using a gravity drop system to control dusting and over application. The biomass carbon granules become an integral part of the litter "cake" throughout each production cycle which enhances moisture sorption, reducing both ammonia (NH_3) and water soluble ammonia (NH_4)[6]; both of which can adversely affects bird health, lowers air quality, and increases energy usage in higher air volume ventilation.

Exhibit C: enviraPAC BIO AG-Carbon® Granules[7]

[4] Tom Tabler, PhD, Extension Professor, Poultry Science, and Jessica Wells, Extension Instructor, Poultry Science; Mississippi State University
[5] Poultry Sciences Association October 2020 – Evaluation of Biochar as a Litter Amendment for Broiler Production.
[6] Poultry Sciences Association October 2020 – Evaluation of Biochar as a Litter Amendment for Broiler Production.
[7] enviraPAC BIO AG-Carbon Granules

As shown in Exhibit C above, *enviraPAC BIO AG- Carbon® Granules* show a consistent and defined structure which is not evident with other traditional lower quality biochars. There is a distinct contrast of a higher fixed carbon (FC) and overall quality when comparing *enviraPAC BIO AG-Carbon® Granules* to traditional biochars. Traditional biochars can possess significantly higher moisture levels and lack consistency due to various process methods as well as various raw feedstocks. EnviraPAC Carbon products are produced using Southern Yellow Pine, located in the Southern Arkansas region, as feedstock obtained through forestry management activities. When used in agriculture or livestock operations, traditional biochar typically have increased volume usage to achieve the same sorption targets required to improve / maintain bird health. A detailed list of important performance metrics of *enviraPAC BIO AG-Carbon® Granules* listed below in *Exhibit D*:

Exhibit D: enviraPAC BIO AG-Carbon® Granule Metrics[8]

a. *H_2O sorption - > 1.92 g/g – granule*
b. *IAN - > 270 g/kg*
c. *OAN - > 70 cm^3/100g*
d. *TPA – 7.42 m^2/g*
e. *Chemisorption (NH_3) - ≥ 1.75 cm^3/g STP*

EnviraPAC BIO AG-Carbon® Granules as supplemental litter amendment can improve overall air quality, litter quality, reduced energy cost, and most importantly improve / enhance bird / flock health. *BIO AG-Carbon® Granules* can adsorb almost twice its weight in water (H_2O), which is a direct component of ammonia (NH_3) formation as well as soluble ammonia (NH_4). From hatchlings to full grown broilers, the incorporation of non-activated carbon granules which is uniform in structure and product mesh size distribution, can also improve the litter cake consistency and composition for reuse in each cycle of broiler production. *EnviraPAC BIO AG-Carbon® Granules* are screened to 5 x 35 Mesh (American ASTEM E 11-87[9]) which is an ideal distribution to address moisture control, ability to apply through a controlled drop spreader, which in turn will reduce overall litter amendment usage and costs. These realized advantages are directly attributed to the *enviraPAC BIO AG-Carbon® Granules* metallurgical and chemical attributes.

Biomass carbon granules used in conjunction with other litter amendments, will translate into a more efficient production / business operation as well as reducing the environmental production footprint. Advanced biomass carbon products are higher in quality and possess key attributes in sorption qualities which can reduce increased poor air quality. Another important chemical advantage is *enviraPAC BIO AG-Carbon® Granules* possess a pH typically ranging from 8-10. This important chemical attribute is critical as a poultry litter (PL) management tool where higher acidic litter compositions can be reduced by using biomass carbon granules to raise the pH to higher neutral or alkaline values.

Currently enviraPAC-Monticello has engaged research collaborations with select universities to assess additional potential attributes of *enviraPAC BIO AG-Carbon® Granules* for Phosphorus (P) management. This has become an important topic in managing surface water quality, which has been directly related to agriculture operations. These include farming, livestock, and in recent years, increased attention on poultry operations were Phosphorus (P) runoff can negatively affect local water supplies, ponds, streams or rivers. In summary, e*nviraPAC BIO AG-Carbon's®* environmentally friendly, sustainable, produced from renewable sources, and the innate sorption properties are ideal in improving poultry litter (PL) quality / management and

[8] Particle Testing Authority (PTA); Lab Analysis Report enviraPAC Carbon Powders & Granules; July 2020
[9] ASTM.org; E11 Wire Mesh Standards

as a viable supplemental option as a litter amendment. EnviraPAC BIO AG-Carbon® Granules have been certified by the International Biochar Initiative (IBI), USDA Certified Biobased Product, and Organic Materials Review Institute (OMRI) approved product as a poultry bedding order control. In addition, enviraPAC-Monticello production facility is ISO 9001:2015 Certified.

Below in *Table A* shows the typical ash composition values by specific elements in *BIO AG-Carbon® Granules:*

Table A: BIO AG-Carbon® Granule Ash Composition Analysis[10]

	Typical Values
Al	<160 ppm
K	<1,200 ppm
Ca	<2300 ppm
P	<250 ppm
Cr	<10 ppm
Fe	<620 ppm
Mg	<780 ppm
Ni	<2.0 ppm
Pb	<0.01 ppm
Sb	<0.1 ppm
Si	<1300 ppm
Ti	<20 ppm
V	<0.3 ppm
S	<1.0 ppm

The elemental analysis in Table A demonstrates the high purity nature of the *BIO AG-Carbon® Granules*, but there are also interesting levels of specific nutrients (K, P, Fe, Mg) which are important in agriculture soil remediation and soil enhancement and the innate ability of the enviraPAC Carbon Granules to adsorb nitrogen; an important nutrient in fertilizer for both agriculture, lawn & garden applications. In summary, biomass carbon granules are an important litter amendment option and it is important to emphasis that enviraPAC BIO AG-Carbon® Granules have specific performance attributes that outperform biochar's and in traditional litter amendments as discussed in this report. Poultry litter (PL) moisture management, ammonia (NH_3) and soluble ammonia (NH_4) formation control is the primary focus of any livestock operation, especially broiler operations.

[10] AETC Lab Analysis Report February 2020; enviraPAC Carbons