VIRGINIA STATE

College of Agriculture

Agricultural Research Station

Impacts 2019-2020

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Economic Benefits of Nitrogen and Phosphorus Removal from Wastewater as Dittmarite

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Who Cares and Why?

Controlling pollutants, like nitrogen (N) and phosphorus (P), is a key factor in the reducing the eutrophication of waterbodies, which creates an overgrowth of algae that negatively impacts aquatic life. Eutrophication occurs when waterbodies are enriched in dissolved nutrients, such as phosphates, that stimulate the growth of aquatic plant life usually resulting in the depletion of dissolved oxygen. This problem is commonly resolved by removing the harmful nutrients on-site.

One method for controlling these pollutants is the on-site removal of P and N from wastewater as dittmarite - a naturally occurring mineral, which is also produced by municipal wastewater treatment processes. In addition to curbing contamination of waterbodies, dittmarite could also be used as a value-added soil conditioner to reduce the high cost of fertilizers for farmers, gardeners and home-owners.

What has the project done so far?

The technology for removing N and P as dittmarite using a pi-lot-scale precipitator was introduced to the public during a field day, which was held at Virginia State University Randolph Farm on August 28, 2019. Previous bench-scale research had developed and enhanced the chemical precipitation method that removed over 90% of P and nearly 20% of N from both synthetic and municipal waste-waters as dittmarite. The objective was to demonstrate to the public that removal of N and P as dittmarite is possible in every rural home and farm. The fertilizer equivalence of dittmarite to mono-ammonium phosphate (MAP), di-ammonium phosphate (DAP) and triple super phosphate (TSP) were shown from chemical analyses data (See Table). Plants grown in the greenhouse using dittmarite as a sole source of fertilizer were also displayed to the public (See Photo). Inference was made as to the use of dittmarite for soil amendment.

What research is needed?

Removal of N and P as dittmarite from various wastewater provides a value-added product that could reduce the cost of fertilizers for the farmer and homeowners. A potential use of dittmarite as a soil amendment was demonstrated to the public on a field day that gen-

Fertilizer	N	P_2O_5	K_2O	CaO	MgO	SO_3
MAP	12	54	0	0	0	0
DAP	18	46	0	0	0.8	3.8
TSP	0	45	0	24	0	4.5
Dittmarite	5.7	28.9	0	0	16	0

erated a great interest in its production process. The economic benefit of dittmarite to the farmer or homeowner can be substantial. Many people (67% of the attendants) were very much interested in the fact that dittmarite (a value-added fertilizer) could be easily produced from wastewater, septic tanks and urine. A table showing a comparison among commonly used phosphate fertilizers and dittmarite was also demonstrated that increased the audience's interest for further inquiry. Dittmarite can supply about half the N and P of MAP and DAP, more than half the P in TSP, and a substantial amount of Mg, which none of the other phosphate fertilizers can provide. and dittmarite was also demonstrated that increased the audience's interest for further inquiry. Dittmarite can supply about half the N and P of MAP and DAP, more than half the P in TSP, and a substantial amount of Mg, which none of the other phosphate fertilizers can provide.

Impact Statements:

- The technology could be used by high volume fish producers, confined animal operators and wastewater treatment plants to produce dittmarite. Small and minority farmers and vegetable producers and gardeners could use dittmarite as a fertilizer additive.

This project was supported by USDA-NIFA 1890 Capacity Building Grant Program; Award # 2014-38821-22462
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Development of Edamame and Specialty Soybeans: A Profitable Option for Rural and Urban Agriculture in Virginia

Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

Small-scale farming agribusinesses in southern Virginia are experiencing loss of income and croplands due to the end of the federal tobacco price support program. Food-grade specialty soybeans (Glycine max), especially edamame, are regarded as a profitable substitute for tobacco or a niche crop. Edamame and other specialty soybeans can be grown similarly to general-purpose soybeans, but have higher market values. Along with more awareness of the nutritional and health benefits of soy food, the demand of edamame and food-grade soybeans has been significantly increased, thus bringing a promising opportunity for increasing farmers' profitability. In addition, growing vegetable and specialty soybeans also helps the diversification of both rural and urban agriculture, as well as food supply. Scientists in the breeding program at Virginia State University's Agricultural Research Station are dedicated to the development of new varieties of edamame and/or food-grade specialty soybeans that are particularly suitable for production in Virginia and the entire United States. The project will benefit crop growers, small and/or part-time farmers, urban gardeners, soy-food processors, as well as suppliers and consumers.

What has the project done so far?

VSU has established a vegetable soybean (edamame) research program and released three varieties. In addition, conventional food-grade specialty soybeans also have been integrated into the program since 2015. Since then, hundreds of breeding lines were evaluated for agronomic performance, yields of fresh pods, fresh seeds, mature seeds and seed composition or nutrients (protein, oil, sugars, etc.). Promising lines have been selected for further purification and seed multiplication. Unique edamame and specialty soybean genotypes were introduced and new crosses were made to develop segregating/breeding populations for selection. Collaboration with USDA-ARS was initiated by planting the USB-Diversity Trials. More than 400 germplasm lines were newly introduced. Evaluation, seed purification and increase of superior lines are in progress. Several new lines have also been introduced to another public breeding program for use and an edamame processing company for evaluation. Related results have been published in several well-known journals and presented at professional meetings. It is anticipated that some of the new superior lines can be released in coming years.

What research is needed?

To meet the requirements of superior varieties, the research will focus on the evaluation and selection of breeding lines for yield and quality of edamame and grain seeds. This will include further purification and increasing of superior lines/varieties for release and development of breeding populations integrated with high yield and high quality traits for edamame and specialty/food-type uses. Post-harvest processing, storage and marketing of edamame/specialty soybeans are also needed.

Impact Statements:

- Several new edamame lines developed by VSU have been transferred to another university for use in their soybean breeding program under a Material Transfer Agreement (MTA).
- Some growers exhibited interest in growing VSU edamame lines after visiting the trials on Randolph Farm and several new edamame lines were introduced by an edamame processing plant for evaluation under a MTA.
- Three research articles on edamame were published in peer-reviewed and well-known field and community journals.

This project was supported by USDA-NIFA Evans Allen Funds and the USDA-NIFA CBG Program
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Sorghum: A Low-Input Bioenergy Crop with Potential in Mid-Atlantic Region

Who Cares and Why?

The environmental impact of fossil fuel use is evident worldwide in the form of air pollution and global warming. Increased public outcry and demand for more earth friendly alternatives drive research to explore the potential of replacing fossil fuel products with bio-based energy sources. Growing concern about climate change and finding solutions to the problem help create a vibrant market for producers of bioenergy crops. One crop that continues to show promise is sorghum, which has been used for centuries for grain and forage. While sorghum has been successfully grown in West Texas, its adaptability to the Mid-Atlantic region is the topic of this study.

Sorghum is better adapted to marginal areas compared to cereals, like corn and wheat. Sorghum tolerates high temperatures and moisture stress, and does well in a variety of soils. Sorghum breeding programs have focused mostly on adaptation to dry and hot environments like those of West Texas. Under such an environment, varieties may be exposed to low fungal disease pressure and their production in the more humid environments of the Mid-Atlantic may be problematic.

The potential uses of sorghum in the region are many. The Mid-Atlantic region is home to thriving poultry and hog operations that may provide markets for grain sorghum. Also, its starch can be used for bioethanol production and local brewing companies in the Commonwealth of Virginia may utilize grain sorghum as an addition to their operations. Sweet sorghum juice is fermented into bioethanol and used as source of energy, while the residual (bagasse) material has potential for forage and can be burned for heat energy. This multi-use crop offers producers reduced production risk due to its low input requirements and a wide market base.

What has the project done so far?

Plant available P may be insufficient in low pH soil in parts of the Mid-Atlantic region and was a focus of this study. Studies over a two-year period have determined, grain seed yield, seed starch and mineral element composition, as well as leftover

stalks mineral composition and forage potential. However, P application rate had no effect on all parameters studied, and therefore P treatments were pooled across varieties. Results showed variety difference in seed yield and quality, residual stalk yield and forage quality.

Also late summer rains during seed maturity has the potential to cause serious infestation by one or more of the commonly prevalent fungal diseases found in the southeastern U.S. Field observation showed field grain losses from bird infestation and difference in fungal disease susceptibility and severity. Deer fed on grain and, in fact, there was a complete loss of grain in the 2019 cropping cycle. The residual stalk yield was high and has potential for both forage and bioenergy use.

What research is needed?

Over the last two years, results have shown good grain yield, and huge residual stalks that can be used for bioenergy and may offer some forage use as a maintenance feed source. However, there is a need for more work on fungal disease control during the seed maturity phase. Also, there is a need to determine the heating energy value of sorghum stalks and sweet sorghum bagasse so as to ascertain its use for heat energy provision.

Impact Statements:

- West Texas developed grain sorghums and sweet sorghum can be grown in Mid-Atlantic region
- Fungal diseases in grain sorghum is a major challenge in the relatively moist Mid-Atlantic region that needs serious attention for a successful crop
- Deer and bird infestation caused significant grain loss in the field

This project was supported by USDA-NIFA Evans Allen Funds.
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Assessing the Safety of Fresh Produce in Food Deserts

Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

People who live in food deserts not only have limited access to fresh food, but they may also be at a higher risk of contracting a foodborne illness due to improper food safety practices.

The USDA describes "food deserts as urban neighborhoods and rural towns without ready access to fresh, healthy, and affordable food. Instead of supermarkets and grocery stores, these communities may have no food access or are served only by fast food restaurants and convenience stores that offer few healthy, affordable food options." The lack of access to healthy food, commonly known as food insecurity, puts this population - typically those with low incomes - at higher health risks.

Even when fresh foods are available at convenience stores or other local, small independent markets (SIM) in these communities, people may be at higher risk for exposure to harmful bacteria due a lack of Good Handling Practices (GHP). Small food markets may not be aware of proper GHP that can keep food safe for consumption. Lack of effective GHP opens food safety vulnerabilities, which can lead to foodborne illness outbreaks within low income communities. It is reported that SIM have more critical and non-critical code food safety violations. Analyses of reported cases have found increased rates of some foodborne illnesses among minority racial/ethnic populations associated with food deserts. Food safety risks associated with local food retailers, particularly in food deserts, are inadequately addressed in research practice or literature. Therefore, there is a valid need for more research in this area since more than 1M Virginia residents live in food deserts. Addressing public health and economic viability of food insecurity is also critical.

What has the project done so far?

A quantitative assessment was conducted on the differences in the prevalence of foodborne pathogens on fresh produce sold at SIM and comparable products found at large chain supermarkets (LCM) in and surrounding food desert areas in central Virginia. In our research, a total of 122 fresh produce samples procured from registered 10 SIM and 9 LCM between September 2018 and April 2019 were assessed. Significantly higher levels of aerobic mesophiles were found in cilantro, collard greens and tomatoes, and coliforms in tomatoes purchased at SIM than samples procured from LCM. Overall 93.8% of LCM and 85.4% of SIM complied

with the food safety inspection guidelines set by local health departments. Regardless of food source, 27.9% *Campylobacter*, 5.8% *E. coli*, and 10.0% *Listeria* of total samples were detected. A total of 47 *Campylobacter*, *E. coli*, and *Listeria* isolates have been tested for their susceptibility to 12 antimicrobials. Our study found that ampicillin showed the highest frequency of resistance among *Campylobacter* (90.3%) and *E. coli* isolates (25%) while nalidixic acid showed the highest resistance in *Listeria* isolates (100%). Approximately 80.6% of *Campylobacter* and 25.0% of *E. coli* isolates exhibited resistance to three or more categories of antimicrobials, meeting criteria for multidrug resistance. This finding indicates that these pathogens may not respond to antibiotics making it harder to prevent and treat foodborne illnesses associated with them, which can lead to higher medical costs. In addition, one *Campylobacter* isolate demonstrated resistance to all 12 antimicrobials tested, an indicator that commonly prescribed antibiotics may not work for a patient infected with the *Campylobacter* present in food products.

What research is needed?

Due to the concern of lack of GHP at SIM, store processed food products and their packaging need to be further assessed for microbial quality and safety. There is a growth in demand for ethnic food partly attributed to the influx of ethnic groups and the increased consumption as consumers explore and broaden their culinary experiences. Yet, food safety information related to those products especially in SIM is unavailable and needs investigation.

Impact Statements:

- This project addressed food safety challenges in food desert areas of Virginia.
- Food safety information obtained from this research raised the dire need for a regional training initiative for stakeholders that will educate them on how to ultimately prevent and reduce incidences of foodborne illness amongst at-risk communities. The training initiative will also further enhance the university's land-grant mission.

This project was supported by USDA-NIFA Evans Allen Funds.
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Plant Health Projects: Integrated Management of Foliar and Soil-borne Diseases of Chickpeas and Other Specialty Crops

Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

The demand for fresh and locally-grown pulses, fruits and vegetables by U.S. consumers has never been greater due to growing health, environmental, food safety and quality concerns about imported produce. These crops, however, are highly vulnerable to a wide range of diseases and arthropod pests because of their succulent nature. Globally, an estimated third (20-40%) of a potential harvest is lost due to diseases, weeds and insect pests. If left unabated, farmers could encounter total crop losses in places, such as the Commonwealth of Virginia, where weather is highly conducive to pathogens. The situation is exacerbated when it comes to limited-resource and underserved small farmers, where a swift management response to such pre- and post-harvest crop losses is often difficult and pricy. Since its opening in March 2018, VSU Specialty Crops Pathology has focused on research studies and outreach geared towards developing integrated disease management strategies to common foliar (leaf, branches and stem) and soil-borne diseases of chickpeas, and other specialty crops. Additionally, the program has collaborated in community garden efforts, VSU Sustainable Urban Agriculture Certificate Program and pilot projects on soil-borne disease management of ginger and hemp.

What has the project done so far?

On Chickpeas: two-pronged approaches are followed to study the biotic and abiotic stresses and to develop management strategies; (1) **Germplasm screening**: a pilot project was initiated in 2018 using 55 lines of cultivated and wild chickpea from the U.S. National Plant Germplasm System in Washington, Pullman and continued with 272 lines and commercial varieties in 2019, (2) **Integrated approaches** to manage chickpea diseases and disorders: a field trial on planting date, fungicide spray and choice of varieties was conducted at Randolph farm in 2019. Pod borers, deer damage and surmounting weed pressure were among the top challenges in addition to Ascochyta blight and other diseases.

On Cucurbits: a Sentinel plot was established as of 2018 to monitor cucurbit downy mildew disease and alert growers in the region using web-based map system (http://cdm.ipmpipe.org/).

Ascochyta blight on chickpea leaves and pod. Pod borer and saprophytic fungus also affect chickpea pods

Cucumber downy mildew: symptoms on upper side (left) and signs of the pathogen on the underside of a cucumber leaf

Southern blight of hemp caused by *Athelia rolfsii* reported (Details can be referred at Mersha et al. 2019; https://apsjournals.apsnet.org/doi/10.1094/PDIS-10-19-2178-PDN)

What research is needed?

Disease intensities in light of the research questions will be studied within the three-year life span of this project. More refined methodologies of the multi-factor field trial and the Germplasm screening are planned for 2020.

Impact Statements:

- Ascochyta and other foliar and soil-borne pathogens are great concerns to chickpea production in the region. Equivalently, a sound IPM package for a successful chickpea production should entail strategies to combat lepidopterous insect pests (pod borers and corn ear worms) and weed infestations (grass and broad-leaved).
- Regular monitoring and early detection of diseases on specialty crops including, but not limited to cucurbit downy mildew is critical in saving crops and increasing farm profitability.

These projects were supported by USDA-NIFA Evans Allen Funds, 1890 Capacity Building Grant and USDA AMC Specialty Crop Multi-State Program Funds. Want to know more? Contact Dr. Zelalem Mersha, (804) 524-2694, zmersha@vsu.edu

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Meat Goats: Reservoirs of Antibiotic Resistant Bacteria Despite Minimal Exposure to Antibiotics

Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

Antibiotic resistance - when germs develop the ability to defeat the drugs designed to kill them - is phenomena that poses a global threat to both human health and the livestock industry. This threat is one that significantly impacts the meat goat industry. In the 2019 National Animal Health Monitoring System (NAHMS) survey, meat goat producers along with private and government stakeholders in the industry expressed concern over the need for research on antimicrobial resistance and enteric pathogens in small ruminants.

Little is known about the diversity and full significance of microbial populations in small ruminant gut. However, E.coli continues to be the number one gut bacteria that impacts the health of farm animals and the public directly. It is an opportunistic pathogen during both viral infections and parasitic infestations, but some strains are also primary pathogens in animals and humans. Additionally, E. coli serves as a reservoir of antibiotic genes that can be transmitted directly to the food chain or to other pathogenic bacteria in animals and the environment. This ultimately results in failure of commonly used antibiotics to clear common infections in animals and humans. The research findings bring awareness and understanding of the role meat goats play as reservoirs of antibiotic resistance genes.

What has the project done so far?

Research focused on screening E. coli isolates from different age groups for antimicrobial resistance and identifying responsible resistance genes. We also evaluated on-farm risk factors associated with colonization by resistant E. coli isolates. Further, we screened the resistance isolates for virulence gene markers and their grouping. We found that the prevalence of antibiotic resistant isolates was higher in younger animals. It was also noted that congregating of animals in small paddocks that had been

used by animals for a long time resulted in higher shedding of resistant isolates compared to grazing on pasture. We also found that the isolates were resistant to antibiotics that had never been used on the farm. Many of the resistant isolates also harbored virulence genes and some belonged to phylogenetic groups that are known to be animal and human pathogens. We found that meat goats on pasture are reservoirs of antibiotic resistant bacteria even in absence of antibiotic use, although, not much attention is given to these species. The environment may play a role in spreading antimicrobial resistant bacteria and genes in pasture animal production systems reaching sites that have no prior antibiotic use. (Publication link. Antibiotics 2019, 8(3), 136; https://doi.org/10.3390/antibiotics8030136)

What research is needed?

There is a need to expand antimicrobial resistant research to involve small ruminant producer farms, abattoirs (slaughterhouses), state fairs and livestock auction sites to document broader status. Further characterization of the significance of E. coli and other enteric microbial and parasitic organisms in small ruminants is needed. Studies on strategies to control enteric pathogens, parasites and reduction of colonization by and shedding of antibiotic resistant bacteria are also needed.

Impact Statements:

- Meat goats of all age groups are reservoirs of antibiotic resistant E. coli, but a higher prevalence is found in younger animals than adult meat goats even in absence of antibiotic use
- Holding animals in small paddocks that had been in use by animals for a long time was associated with more shedding of resistant E. coli isolates compared to having animals on pasture
- Resistant genes detected in isolates have potential to be passed on to other bacteria in the environment or in the gut of the animals
- Some resistant isolates belonged to the zoonotic pathogenic E. coli strains (O103 and O26) and also had virulence gene markers
- Training is needed to educate producers and public on proper handling of goats or their products to minimize risk of transmission of resistant strains

This project was supported by USDA-NIFA Evans Allen Funds.
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Impact of Potentially Heavy Metal Contaminated Soils On Urban Farmers and Vegetable Growth

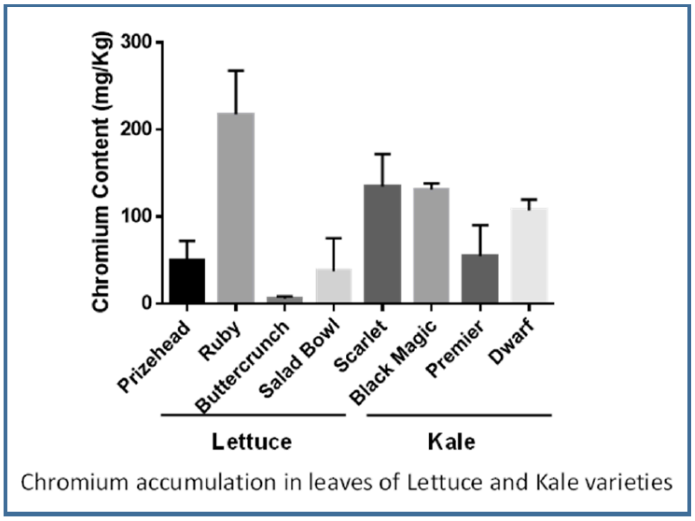
Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

Urban agriculture is popular in the United States due to the increasing demand for fresh, local foods. However, many urban lands are potentially contaminated by various heavy metals, such as lead and chromium, due to human activities and historic use of the lands. These potential contaminants create major safety concerns on consumption of urban produce. Identifying new species or varieties of vegetables that tolerate heavy metals and allow less metal accumulation in their edible part is the key to urban agriculture. Most literatures only identified and provided information on what vegetable species are relatively safe to grow on certain heavy metal contaminated soils for the purpose of human consumption. However, based on our studies conducted on purslane, genetic variation on heavy metal accumulation among varieties within species are dramatically different. It is more important to identify specific varieties within the species on their abilities to accumulate heavy metals on edible parts. Such information is essential to guide urban farmers on what marketable produce they can grow and harvest on potentially heavy metal contaminated urban soils.

What has the project done so far?

At the Virginia State University, we conducted a greenhouse study to screen two leafy vegetables, kale and lettuce, for their ability to grow on potentially heavy metal contaminated soils. For each species, four varieties were included and all were treated with three times of 200ppm either chromium VI (Cr-VI) or lead (Pb) during their growing season. In general, kale accumulated significantly more Cr in its edible part than lettuce did. All 4 kale varieties accumulated more than 100mg/kg of Cr in their leaves. However, among 4 lettuce varieties, only Ruby accumulated over 100mg/kg of Cr. The other three varieties accumulated significantly less Cr. Butter-Crunch variety accumulated only about 5mg/kg, and Salad Bowl and Prize-Head accumulated 30 to 50 mg/kg. When examining Pb accumulation, all 4 kale varieties accumulated very little (less than 3 mg/kg) Pb, which is in a safe zone for human consumption. However, lettuce showed a significant variation for Pb accumulation with Prize-Head accumulating less than 2mg/kg, Butter-Crunch 27mg/kg, Salad Bowl 40mg/kg and Ruby over 180mg/kg. These preliminary results clearly demonstrated that heavy metal accumulation in the edible part is dramatically varied, not only between species, but also among varieties within the same species. The information is essential to advising urban farmers on selecting appropriate species and varieties to grow on their potentially heavy metal contaminated soils.



Chromium accumulation in leaves of Lettuce and Kale varieties

What research is needed?

With the results obtained from the current study, it is necessary to screen more leafy vegetables and identify more species and varieties that can be grown on contaminated soils and consumed safely by humans. We will also expand the screening process to root vegetables, as well as fruit vegetables.

Impact Statements:

- Discover new knowledge on variations of heavy metal accumulation among leafy vegetables
- Provide practical guidance for urban farmers on how to select suitable vegetables/varieties to grow on potentially heavy metal contaminated soils

This project was supported by USDA-NIFA 1890 Capacity Building Grant Program; Award # 2018-38821-27735
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Building Research Capacity on Hops (Humulus lupulus) Through Professional Development

Who Cares and Why?

Virginia hop growers are interested in producing a crop that can meet the exacting quality standards of a growing craft beer industry. Similarly, craft brewers in Virginia are willing to support local farmers if they can supply hops and other brewing ingredients at competitive prices. It falls on scientists at the two Virginia land-grant institutions, Virginia State University (VSU) and Virginia Tech (VT), to provide information and guidelines to both interest groups.

What has the project done so far?

In 2018, the VSU hop research and Extension program principal investigator (PI) spent about a month (June/July) at the Gent Lab (USDA-ARS National Forage Seed Production Research Center) in Corvallis, Oregon on a professional development mini-sabbatical. Activities during the visit included field scouting, application of treatments and sampling as part of ongoing hop pathology research. Through interactions with the hop breeding program at the USDA-ARS, the PI is also now part of a collaboration to evaluate heat tolerance among cultivars currently in production. Lessons learned, including from visits to the Brewing Lab at Oregon State University, will be useful in building technical capacity for hop production, processing and marketing in Virginia.

What research is needed?

Top research needs include identification or development of hop cultivars suited to the mid-Atlantic, setting agronomic benchmarks and identifying interventions for pests and diseases common to the region. Cost-effective harvesting and postharvest handling solutions for small growers must also be developed.

Commercial hop yard in Yakima, WA

Brewing lab at Oregon State University

Impact Statements:

- New knowledge on commercial hop production, processing and handling shared with 150 Virginia growers and other stakeholders in 2019.
- Establishment of linkages with scientists at the USDA-ARS National Forage Seed Production Research Center that will continue to benefit hops research at VSU.
- Collaborative research work with the breeding program at the USDA-ARS (one paper in preparation).

This project has been supported by the USDA-NIFA 1890 Institution Professional Development (Award# 2018-38821-27739).
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Specialty Crops for Reducing Chronic Diseases in Virginia: Ginger, Turmeric, Plum and Papaya

Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

Chronic diseases, such as obesity, cancer, diabetes and cardiovascular disease, are prevalent in society. While not a cure, research shows promising signs that consuming specialty crops, such as ginger, turmeric, plums and papayas, have important health benefits that can help control or slow down the progression of these diseases. In Virginia, the obesity rate in adults is 30.1%, according to the 2018 State of Obesity: Better Policies for a Healthier America report. Obesity is one of the leading contributory factors in developing chronic diseases including cancer, cardiovascular diseases and diabetes. In Virginia, cancer is the leading cause of death, followed by cardiovascular disease. About 5.9% of Virginians are living with a variety of cardiovascular diseases, while 9.6% Virginians (nearly 1 in every 10) are living with diabetes, which is the 7th leading cause of death in the state. While those numbers are disconcerting, more awareness of how consuming foods that help prevent and treat chronic diseases, particularly obesity, is helping to educate consumers about the health benefits gained from ginger, turmeric, plums and papayas.

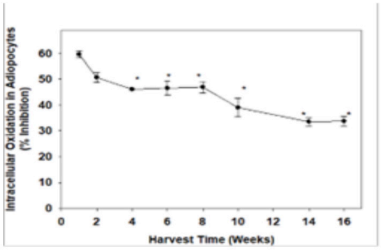
Modern science has discovered that most food contains effective disease preventive biomolecules that can improve our health and reduce our risk for many diseases including obesity, diabetes, cardiovascular diseases, cancer, poor bone health and neurological diseases. The Food Chemistry and Nutrition Science laboratory at Virginia State University is actively involved in investigating beneficial effects of fruits and vegetables for preventing and/or treating chronic diseases. The purpose of this program is to introduce new profitable crops in Virginia for promoting agriculture-based business development and human health and nutrition. Promotion of the health benefits of these crops will help encourage the public to consume certain types of produce to reduce or slow down the progression of chronic diseases. The program will also provide incentives for farmers to grow these crops in Virginia.

What has the project done so far?

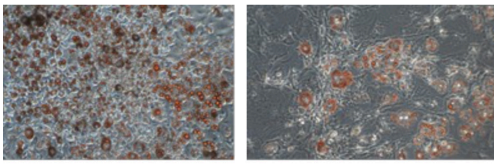
Ginger (Zingiber officinale) is a new emerging niche crop for small farmers in Virginia. There are several varieties of ginger including white, yellow, pink and blue ginger. Currently, only white ginger is locally grown which is not fully mature, and is marketed under

Figure 1: Baby Ginger (left) and Mature Ginger (right)

Figure 2: Antioxidation activity in Ginger



'Baby ginger' (Figure 1). We performed a comprehensive phytochemical analysis of baby and mature ginger and found that baby ginger contains high levels of phenolic compounds and superior antioxidation activity (Figure 2) than mature ginger. The extract from ginger effectively reduces lipid deposits in adipocytes (fat cells) (Figure 3). The phenolic compounds and antioxidation activity in turmeric (Curcuma longa) increased over time as harvesting progressed. The active component curcumin has strong anti-inflammatory activity and anti-cancer activity for breast cancer. Plums (Prunus subg. Prunus), which are rich in antioxidants, inhibit glucose breakdown by inhibiting a-amylase and a-glucosidase activity. Consuming plums can be effective in preventing diabetes. Papaya (Carica papaya) seeds possess wound healing activity and has a potential to be used for treating diabetic wounds, a complication that is common in diabetes patients.



Adipocytes (-Ginger) Adipocytes (+50 µg/ml Ginger)

Figure 3: Anti-obesity in Ginger

What research is needed?

Further research is needed to evaluate different varieties of ginger (white, yellow, pink, and blue ginger) for their potential health benefits against obesity. Investigation is required for the potential benefits of plums to be used for anti-diabetic activity, and studies for papaya seed extract to improve the diabetic wound healing in animal models.

Impact Statements:

- Small Fruits and Vegetable Program conducted a statewide ginger and turmeric workshop attended by more than 95 interested growers and other individuals
- Locally grown "baby ginger" is superior for its nutrients contents and its anti-obesity effects than that of mature ginger. Consuming baby ginger can lower the incidences of obesity. In 2019, Virginia consumers had access to locally grown ginger and turmeric substituted for imported ginger and turmeric from other countries. A total of 3,000 lbs. of ginger and 2,000 lbs. of turmeric with a total value of $55,000 was sold by Virginia growers at local markets.

This project was supported by USDA-NIFA Evans Allen Funds.
Want to know more? Contact Dr. Rafat Siddiqui, (804) 524-5957, rsiddiqui@vsu.edu

Extending Shelf Life of Fresh Ginger and Turmeric

Who Cares and Why?

Small, limited-resource producers are filling a market niche by growing ginger and turmeric to satisfy the demand of health-conscious consumers. However, the growing season is not long enough to grow mature ginger and turmeric. To overcome the challenge, these producers grow them under high tunnels and harvest them before the frost, while the crops are still immature, as shown in the picture. The immature ginger and turmeric are prone to water loss and fungal diseases. Producers must be able to use different storage techniques to reduce water loss and control fungal diseases in order to extend their shelf life for fresh market. Otherwise, the poor quality produce cannot be marketed and result in complete crop loss and business failure.

What has the project done so far?

Researchers at Virginia State University have grown ginger and turmeric inside high tunnels at Randolph Farm. The produce was assessed for water content, sugar, titratable acidity and fungal contamination right after harvest and every week during storage for four weeks. Two different temperatures have been tested in the first year and two different packaging in the second year. Thus far, results have indicated which packaging material is most effective in reducing fungal contamination and water loss. Determinations and recommendations have also been made. This information has been disseminated to growers through a ginger and turmeric field day and the Annual Meeting of American Society for Horticultural Science.

What research is needed?

Since the research is new and ongoing, it is difficult to quantify impact at this point in time. So far, research indicates the importance of proper temperature, relative humidity and packaging material in reducing water loss and fungal decay. Paper packages were the most effective to maintain the tuber quality and clamshells the least. However, more research is needed to identify the proper storage temperature and relative humidity.

Impact Statements:

- Early research findings indicate the importance of proper temperature and relative humidity in reducing water loss and fungal decay to extend the shelf life of ginger and turmeric.
- Preliminary results show that paper packaging is the most effective to maintain the tuber quality and clamshell packaging is the least effective.

This project was funded by the Center for Agricultural Research, Engagement & Outreach (CAREO) - 2018
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College of Agriculture
Agricultural Research Station

Raising Healthier Meat-Goats on Gamagrass Pastures Without Grain Supplements

Agricultural Research Station - Impacts 2019-2020

Who Cares and Why?

Eastern gamagrass is a native, warm season, perennial, bunch grass that is used primarily as livestock forage. The plant – a distant cousin of corn - could be an important link to healthier, forage-raised small ruminants.

With growing consumer preference for products, such as meat and milk, from forage-raised small ruminants, it is critical that livestock producers have beneficial information about dependable forage resources and drug-free parasite control strategies. Summer forage shortages and gastrointestinal parasites are the biggest concerns for sheep and goat farmers. The worms, which live in the animals' intestinal tract, lay eggs that are transmitted through manure. The animals become infected when they eat the larvae from contaminated pastures, creating a continuous and costly cycle for farmers.

In Virginia and neighboring states that experience severe forage shortages during the summer and losses to parasite infections, farmers need dependable warm-season forages and plant-based alternatives to chemical anthelmintics, which prevent the worms from absorbing the sugars they need for survival.

Farmers need to be less dependent on costly hay and energy supplements, such as corn. Basically, producers need to implement grazing strategies that make animals less likely to ingest parasite larvae and, effectively incorporate bioactive forages in their feeding systems. Farmers also need information on how to improve the consumption of bioactive forage plants that are inherently resistant to herbivory by small ruminants.

What has the project done so far?

At Virginia State University, a research study is being conducted on the growth and health conditions of meat goats grazing on gamagrass supplemented with stinging nettle pellets. In the grazing experiment, animal live-weight changes, body condition scores and symptoms of parasite infections are being monitored. Preliminary results indicate that meat goats can successfully be raised on gamagrass pastures without grain supplements and suffer less parasite infections if also offered stinging nettle pellets.

What research is needed?

Subsequent studies will compare the performance of meat goats on gamagrass pastures that are inter-grown with legumes with and without bioactive forages and not fed any grain supplements. Other studies will also assess suitability of the gamagrass and bioactive forage mixtures for eco-friendly small ruminant production in silvopasture systems, which integrate trees and pasture into a single system for raising livestock. Matching spatial distribution with biomass yield remains a challenge.

At flowering, gamagrass can be harvested (top), directly grazed by goats (middle) and supplemented with nettle pellets (bottom). Matching forage biomass to stocking density favors efficient utilization.

Impact Statements:

- Research students witnessed grazing behavior of goats on tall-growing bunch grasses.
- A demonstration trial for grass-fed meat goat production was established.

This project was supported by USDA-NIFA Evans Allen Funds. Want to know more?
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College of Agriculture
Agricultural Research Station

Proof of Concept: Sustainable Year-Round Lamb Production

Agricultural Research Station - Impacts 2019-2020

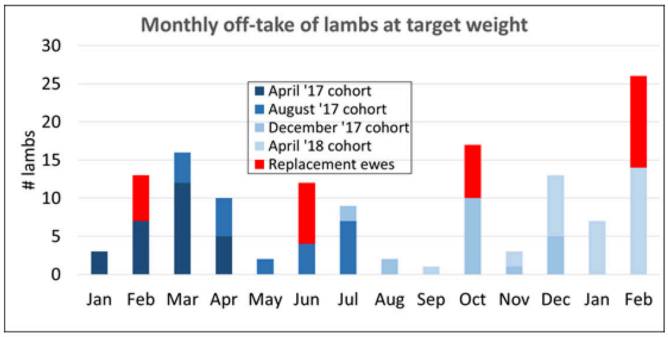
Who Cares and Why?

Traditional sheep production systems are limited by a consistent supply of lamb due to the seasonality of breeding, lack of uniformity of product resulting from variations in litter size, and high inputs in labor, facilities and harvested feed. There are expanding niche marketing options for lamb that include farmers markets, custom processing and internet sales, high end restaurants, CSAs and food hubs, as well as ethnic customers. To be successful in these markets the issues of seasonality, product uniformity and lowered production inputs need to be addressed, while also catering to shifting consumer preferences for locally produced and forage-fed product. Heritage and landrace breeds have production characteristics, such as extended seasonal breeding and utilization of lower quality forages making them well suited for alternative production systems, while also ensuring breed survival.

What has the project done so far?

Using 60 Barbados Blackbelly and St. Croix hair sheep, a system was designed based on accelerated mating and a multi-flock breeding scheme to produce lambs in 4-month intervals. Animals in the system rotationally grazed perennial cool season grass, along with warm and cool season annuals, and were provided agro-byproduct (soy hull) as needed.

All lambs were managed in a single flock and marketed at a target weight of 35 kg. Ewes achieved pregnancy rates of 94% during peak seasonal breeding (November mating), and 86 - 87% during transitional periods going in (July) and coming out (March) seasonal breeding. Litter size averaged 2.1 lambs following November mating and 1.7 - 1.8 lambs during transitional period mating. Cohorts of 40 to 50 lambs were produced at weaning, and 75 to 80% reached market weight as yearlings. Between 2 and 25 lambs reached target weight or were removed as replacement at monthly intervals (Figure) in the first four cohorts managed under the system.



What research is needed?

Additional research is needed on use of alternative forages and grazing management that will extend and improve seasonal grazing. In cooperation with Laval University a computer simulation model is being developed based on their 'Simulovins' software that will allow evaluation of changing inputs on biological efficiency and economic viability of the production system. Lamb marketing options will be evaluated that will capitalize on the forage-raised nature and year-round availability of lamb produced under this system.

Impact Statements:

- Landrace hair sheep have the potential to produce lambs throughout the year using accelerated mating and a dual flock mating system
- Producing sets of market lambs of uniform weight at monthly intervals provides opportunities for more effective and sustainable marketing of product

This project was supported by USDA-NIFA 1890 Capacity Building Grant Program; Award #2018-38821-27767
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College of Agriculture
Agricultural Research Station

Effect of Enzymatic Hydrolysis on Secondary Structure, Functional and Antioxidant Properties of Chickpea Protein Hydrolysates

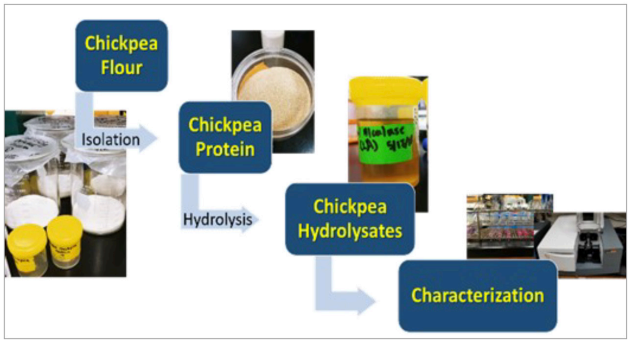
Who Cares and Why?

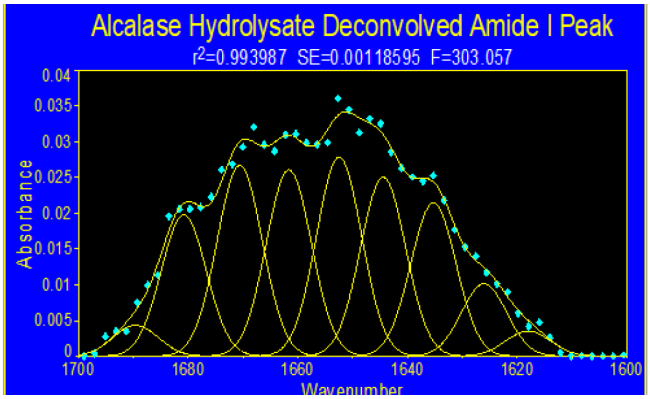
Health conscious consumers who want the benefits of protein, but without the meat, are creating a demand for new products in the plant-based protein industry. Legumes, such as chickpeas, lentils, peas, beans, soybeans and peanuts, are high in protein. Plant-based proteins are deemed as healthier alternatives to meat-based proteins and are believed to reduce risks of developing health conditions, such as cancer, type 2 diabetes and heart disease, while helping with weight control. Because of that, legumes are becoming the next new "hot" protein source. Chickpeas, which are packed with nutrition and a good source of dietary protein, are at the forefront of this growing global trend.

According to the USDA Economic Research Service, sowings of chickpeas were forecasted to reach a new record high of 665,000 acres in 2018, a 7% increase over 2017 plantings. The development of new plant-based products is not only giving consumers more options for a healthy diet, but also creating an interest in how these products provide greater health benefits. As a result, there is growing interest in the hydrolysis of protein (a chemical reaction in which water is used to break down a compound) to generate hydrolysates (substances produced from hydrolysis) and peptides (compounds consisting of two or more linked amino acids) to improve protein's functional quality and bioactivities for potential health benefits. Different hydrolysis methods can have different impacts on protein. Enzymatic hydrolysis shows good potential in modifying protein structure to improve functional properties without comprising nutritional value. Use of a sequential hydrolysis by combining the enzymes Alcalase and Flavourzyme would be a good option to produce hydrolysates with better functional properties. Therefore, it is very important to understand the changes in structural and functional properties of chickpea proteins caused by different hydrolysis methods.

What has the project done so far?

Researchers have conducted studies to hydrolyze chickpea protein isolate (CPI) batchwise using Alcalase as an endopeptidase





and Flavourzyme as an exopeptidase, by either individual or sequential treatment. Then, secondary structure, molecular weight profile, functional properties and antioxidant activity of the hydrolysates were investigated. The results reveal that hydrolysis enhanced the functional properties and antioxidant activity of chickpea protein, which may be beneficial for potential functional food ingredient applications.

What research is needed?

More research is needed in the areas of analysis of amino acid composition and surface hydrophobicity (ability to repel water) of these hydrolysates.

Impact Statements:

- Helped nutritionists and food scientists understand effects of hydrolysis approaches on nutrients and functional properties of chickpea proteins
- Helped food industry professionals choosing appropriate hydrolysis methods and conditions to enhance the functional and antioxidant properties of chickpea protein
- Provide students hand-on training, critical thinking and problem-solving opportunities

This project was supported by USDA-NIFA Evans Allen Funds.
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Recycling Crop Residues Show Potential as Food, Feed and Fertilizer in Small Ruminant Production

Who Cares and Why?

Small ruminant production in the United States is an emerging, non-traditional alternative agricultural enterprise. Production increased by about one-third in the past decade due to demand for small ruminant meat from specialty markets. This trend is expected to continue to grow as a result of changes in demographics, as more Hispanic and Muslim populations, who are the biggest consumers of goat meat, enter the United States.

Profitability of livestock production enterprises is greatly influenced by feed cost, which accounts for the largest cost of production. The use of crop residues could help producers circumvent the high cost of feed. Crop residues - the major waste of agricultural production operations - accounts for around 85% of total solid wastes generated. It can be included as a cheaper alternative feed ingredient, unlike some grains which form the bulk of the staple human diet and are expensive. Crop residues are low in dietary protein and high in indigestible fiber. Quality for use as source of food, feed and even fertilizer can be improved by physical, chemical and biological treatments.

What has the project done so far?

At Virginia State University's Agricultural Research Station, researchers are evaluating biological treatment of several crop residues with edible mushroom. Edible white rot fungi (mushroom) is cultivated on crop residues (substrates) abundantly produced in the area, such as corn stover (stalks) and vegetable straw. The study evaluates the potential of the residues on the growth and physiochemical properties of the mushroom, the effects of the mushroom growing on the residue used as substrate and the spent mushroom recovered.

What research is needed?

Further studies are needed to explore important roles biological treatment of crop residues play in:

- Biological efficiency of mushroom
- Physiochemical properties of the mushroom, substrate (crop residue) and the spent mushroom
- In vitro and in vivo assessment of nutritional quality
- Effects of feeding spent mushroom on small ruminant health

Impact Statements:

- Research findings will facilitate and enable the recycling of agricultural waste into high protein food (mushroom), feed for ruminant livestock and fertilizer in organic farming.

This project was supported by USDA-NIFA Evans Allen Funds.
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