A Small Scale System for Grape Seed Value-Added Products from Oklahoma Winery Waste

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Project emphasis area: Research and Education, projects to advance the Oklahoma viticulture and enology industry through research and development

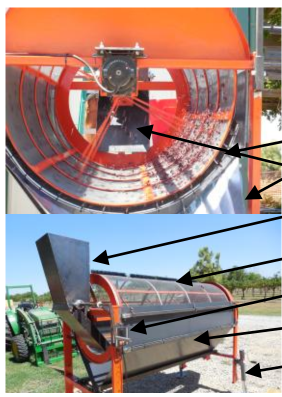
Introduction and Background: To date we have developed small scale procedures and either obtained small equipment or modified available equipment for developing new Oklahoma products from winery waste, with a focus on products which can be derived from grape seeds. We have assisted Redbud Farms located in Washington, OK in developing the steps necessary to clean and process the seeds from Oklahoma winery pomace and subsequent production of grape seed oil and grape seed flour as new Oklahoma products. With the steps now identified for producing value-added products from Oklahoma winery waste, we propose now to a) optimize the steps as components of a new Oklahoma processing system, b) chemically characterize the new products to allow nutritional labeling of the products and c) assist Redbud Farms in product label development as a critical step towards marketing of new Oklahoma products.

Grape seed are a component of grape pomace - a current “waste” product of wine and juice making which represents un-captured revenue for the Oklahoma grape industry. Seed represents approximately 26 % of the weight of grape pomace on a fresh basis and pomace represents about 14 % of the weight of grapes prior to pressing for wine or juice manufacturing. According to the most recent ODAFF grape industry study conducted in 2011, Oklahoma vineyards occupied 439 acres in Oklahoma (up from 375 acres in 2002). With an average grape yield of 2.4 tons per acre, this represents about 1,054 tons of grape production which in turn represents about 148 tons of pomace containing 38 tons of seed. The seeds must be dried from about 34 % moisture to 11 % moisture to stabilize them for storage and precondition them for efficient oil yield during pressing, reducing potential seed weight to about 29 tons.

Oklahoma’s wine grape industry is relatively small in comparison to many other states. California topped wine grape production within the US accounting for nearly 90% of wine grape production at 3.24 million tons in 2007 (Hodgen, 2008) and up to 4.02 million tons in 2013 (California Department of Food and Agriculture). Pomace from California’s yearly wine grape production would produce over 110,600 tons of grape seed at 11 % moisture. Our neighboring state of Missouri had over 1,350 bearing acres of wine grapes with a yield of 2,800 tons of grapes in 2007 (containing 78 tons of dried seeds) and almost 3,600 tons harvested in 2010 (containing 100 tons of dried seeds; Harris et al., 2010). Texas is another neighboring state with 3,000 bearing acres and production of 8,900 tons of wine grapes (containing 249 tons of dried seeds) in 2010 (Lewis and Johnson, 2011). While equipment is available for grape pomace handling to obtain a relatively pure seed fraction and process the seed into oil (8 to 16 % of the weight; Crews et al., 2006) and grape seed meal (84 to 92 % of the weight), it has been designed to service large production volumes. For example, a common seed separator (Bertocchi turbo finisher/extractor) can handle 20 to 50 tons of pomace per hour at a cost of over $100,000. Seed presses to obtain oil at this scale of production will cost over $300,000 for a 5 to 10 ton per hour processing capacity. Our objective has been to scale down and economize each step for pomace utilization, with a goal to develop the steps necessary for production of value-added seed products which are appropriately sized for our industry.

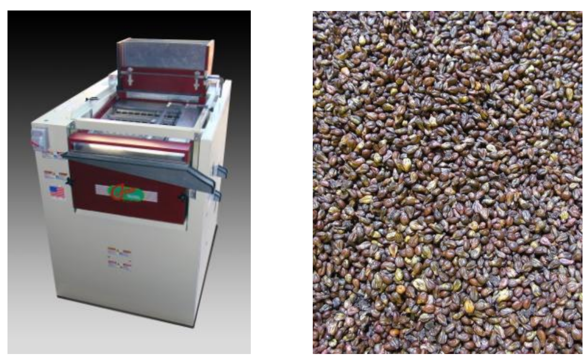
Our progress to date which is summarized in figure 1 has focused on developing technologies in steps for grape seed product development including seed separation from fresh pomace (step 1), low cost grape seed drying (step 2), final seed cleaning (step 3), seed oil pressing (step 4) and presscake milling/oil clarification (step 5). Each step in the process thus far was developed to accommodate our industry

Figure 1. Steps accomplished for processing grape pomace into new Oklahoma products.



Step 1. Rotary seed separation from fresh pomace - cleaner with improvements installed

a) brushes to keep exit clean, angled trough to prevent skin clogging
b) pomace breaker/feeding mechanism
c) Rotary cage brushes to keep screen clean
d) motor speed control dial
e) Permanent seed trough
f) jacks to change screen angle



Step 2. Seed drying.

Step3. Final seed cleaning.

Step4. Seed oil pressing.

Step5. Press cake flour and oil.

size - to handle 29 tons of seed for Oklahoma production; if pomace obtained from neighboring state's wineries in close proximity to Oklahoma produced an equivalent amount of seed, production capacity would be close to 60 tons of seed per year producing 4.8 to 5 tons of oil (1,370 to 1,430 gallons) and about 55 tons of seed meal. **With the steps now in place for pomace processing into value-added seed**

products, it is now time to demonstrate their performance as components of a processing system, eliminate operational inefficiencies and adjust operations to assure consistent high quality, and characterize the new products to the extent necessary to accommodate product labeling and marketing. Our project aims to vastly improve profitable operation of a new business in Oklahoma and convert a current waste stream into a viable business enterprise for our state.

Values for new products are difficult to exactly establish; since grape seed oil and grape seed meal and products obtained from the meal are in the marketplace, current values can be used as a guideline. If Oklahoma's production capacity of 29 tons of dried seed were processed, the seed would yield 7,524 lbs of oil (1,075 gallons) and 50,236 pounds of de-oiled meal (25 tons). Current bulk prices of grape seed oil are $3.34 per pound or $23 per gallon; retail prices for consumer sized quantities range from $13 per 500 ml ($98 per gallon) to $25 per 375 ml ($253 per gallon) for variety specified oils. Oklahoma's potential for grape seed oil production value ranges from $24,725 at bulk prices, $105,350 at consumer-sized prices and $271,975 at boutique, variety specified prices. The de-oiled seed powder may be ground and sold as-is in bulk for $7 per pound; prices are as high as $13 per pound for variety specified grape seed powders. Grape seed may also be extracted with 50 % ethanol (Vayupharp and Laksanalamai, 2012) to yield more pure phenolic compounds (especially proanthocyanidin; reported yield of about 15 % of total seed weight with the extract containing 33 % total phenolics) for $37 to $40 per pound in bulk. The de-oiled meal would then carry a value of $351,652 if ground as-is and sold in bulk or $653,070 if sold as variety specified seed meals. A grape seed extract from the de-oiled grape seed meal would carry a value of $286,345 if extracted and sold in bulk as a grape seed extract. The grand total worth of Oklahoma vineyard grape seeds could then range from $376,377 (bulk oil/seed powder sold as-is) to $558,320 (High end oil/grape seed extract) to $925,045 (High end oil/variety specified seed meal). If pomace from neighboring states were obtained in equivalent volume to Oklahoma's production, the numbers could double.

We initiated our study to develop small scale processing techniques because the throughput capacities and cost of large scale equipment did not fit our industry. Divided into steps of the process identified in figure 1, equipment costs are $4,000 for pomace seed separation in step 1, $400 per drying chamber for seed drying (3 chambers were needed for continuous operation from the pomace seed separator equaling $1,200) plus $250 for a seed moisture meter to prevent over-drying in step 2, $8,000 for a Clipper seed cleaner plus appropriately sized seed screens for final seed cleaning in step 3, $14,000 for a single head seed press for oil pressing in step 4, $3,800 for a cake breaking mill and $2,800 for a stone mill to manufacture grape seed flour plus $5,000 for an oil filter press to clarify grape seed oil in step 5. The total equipment cost to produce new grape seed products from the Oklahoma grape waste product comes to $39,050. While the equipment was sized to accommodate pomace production on our scale of operation (perhaps 1 to 2 tons of pomace per day), we are unsure how each step fits together into a process stream, and how the process stream needs to be modified to match throughput capacity with high product quality. **One goal of this project is to demonstrate and optimize scaled and sequenced operation of the processing steps required to convert our pomace waste stream into value-added seed products in order to balance throughput capacity of each step with production capacity of the process.**

The new Oklahoma grape seed product venture can only be successful if its products meet or exceed the level of quality available from other sources, and is competitively priced. Our work to date has focused on development of cost effective steps for small-scale processing of grape pomace into grape seed oil and grape seed flour. As noted above, our proposed work is intended to combine the steps in the process into a system – a whole which maintains its existence through the mutual interaction of its parts (Bellinger, 2002) and which culminates in a product of definable characteristics and quality. Our goal to demonstrate and optimize the pomace handling system for production of grape seed oil and flour is intimately associated with definition of quality of the products. **Another goal of this project is to assess and document quality of the new Oklahoma grape seed oil and grape seed flour products during and after system optimization in enough detail to allow nutritional labeling of the final products.** We propose to conduct specialized analyses of the products in-house at OSU and we also propose to have third party impartial analyses for nutritional labeling of the final products run via a commercial lab. Through assets in place at the OSU Robert M. Kerr Food and Agricultural Products Center we will assist in development of product labels and packaging to initiate marketing for the new products. *The culmination of our project should be a system for small scale grape seed product generation and nutritional attributes of the new products generated to assist in bringing the products to market.*

Grape seed phytochemicals include oil (8 to 16 %; Crews et al., 2006) and the de-oiled meal is quite high in extractable polyphenolics (seeds are 6-8 % phenolics of which 60 to 70 % is extractable; Nawaz et al., 2006) consisting primarily of flavanoids, flavan-3ols, gallic acid, catechin and epicatechin. Grape seed oil is exceptionally high in omega-6 fatty acids (linoleic acid; from 68 to 73% of total fatty acids) and contains considerable quantities of tocopherols and tocotrienols , as well as phytosterols; the oil fatty acid profile appears to be much more consistent than tocopherols, tocotrienols and phytosterols in seeds obtained from different cultivars (Beveridge et al., 2005). The oil may be filtered and sold and the meal may be sold after grinding to a specified sieve size as-is or it may be extracted with 50 % ethanol to yield a grape seed extract (GSE) containing principally proanthocyanidins (Vayupharp and Laksanalamai, 2012). Whereas the grape seeds are mostly 8 to 16 % oil, the remaining 84 to 92 % of weight has value which should be exploited. Fresh or de-oiled grape seed is an excellent source of polyphenols (Kammerer and Carle, 2008; Maier et al., 2008) which can be extracted with 50 % ethanol at yields of about 15 % of the seed weight and producing an extract which contains about 33 % polyphenol (Vayupharp and Laksanalamai, 2012). The extract is commonly further purified using preparative column chromatography (Amberlite XAD-8 or XAD-16 resin) to concentrate proanthocyanidins which exist primarily as oligomeric proanthocyanidins (OPC). In commerce, the OPC powders are typically standardized to 95 % OPC. Phenolics from grape pomace are strong antioxidants (Woodman et al., 2005; Vayupharp and Laksanalamai, 2012) and exhibit antimicrobial activity (Sagdic et al., 2011), making them valuable additives in food products. They also exhibit interesting medicinal value – grape pomace has specific activity in preventing obesity-mediated chronic diseases such as type 2 diabetes (Chuang and McIntosh, 2011); grape phenolics have activity against memory loss in mice (grape seed extracts were more effective than grape pomace extracts; Jamshidzadeh et al., 2010) and in humans (Pasinetti and Ho, 2010) where they exhibit effectiveness against dementia and Alzheimer's disease. Phenolic content differs considerably among cultivars (red grapes appear to have the highest concentrations; Sagdic et al., 2011).

To our knowledge pomace produced from Oklahoma grapes is handled entirely as a waste product. ***We favor conversion of this current waste into a profit stream to enhance the competitiveness of Oklahoma's wine grape industry and reduce waste associated with the industry***. Our cooperators (Terry and Susan Boehrer, Redbud Farms) agree and have expressed a serious interest in an Oklahoma grape seed products business (see letter attached). The Boehrers have much more than a passive interest in the Oklahoma wine grape industry with Susan as the new Oklahoma Grape Industry Council President. We plan to conduct steps 1 and 2 on site at Redbud Farms in Washington, OK and then complete steps 3-5 within the pilot processing facilities of the Robert M. Kerr Food and Agricultural Products Center on campus at OSU. This resource allows us to conduct the critical seed cleaning, oil pressing, grape seed oil handling and grape seed flour generation steps within an FDA/USDA inspected food handling facility, which will also accommodate bottling and packaging of the new Oklahoma products for initial test marketing and promotion.

Research Objectives and Methodology: We intend to combine the steps shown in figure 1 into a small scale system for grape seed product generation and then identify and modify critical points in the system which limit throughput and/or yield or which negatively impact quality. We will assist our cooperator (Redbud Farms in Washington, OK) in label development and packaging for the new products as a final step towards creating value from a current Oklahoma grape waste stream. We propose to focus on two research objectives designed to a) demonstrate and optimize a complete grape seed processing system, combining the steps for pomace seed acquisition, seed drying, seed cleaning, oil extraction and presscake handling with product packaging to bring the new products to market, and b) provide needed chemical characterization to assess quality of the new Oklahoma products, provide guidance for system tweaks to improve product quality and assure high market value, and develop nutritional labeling for the products. Equipment alterations to improve performance and final product quality will be accommodated by the Biosystems and Agricultural Engineering machine shop. Pomace seed acquisition and seed drying will be accomplished on-site at our cooperator's facility. Final seed cleaning, oil pressing and meal handling steps will be conducted at the Robert M. Kerr Food and Agricultural Products Center in the pilot food processing facility in order to produce products for chemical testing and which can be directly market tested. This project builds substantially on previously funded projects, bringing the steps developed in these projects into a processing system with final products for nutritional characterization and labeling. The project is on target with our original desire to "build a grape value-added products core at Oklahoma State University, with a short term goal of devising scalable means to extract and analyze the quality of valuable components from grape pomace and a long term goal of becoming a clearinghouse for new product development for the Oklahoma viticulture industry." In fact, this project goes farther than our original goal in that it provides a launching pad for the new Oklahoma grape products, providing assistance for nutritional labeling and product packaging to initially market the products.

We will obtain white and red wine grape pomace from the Canadian River Vineyard and Winery in Lexington, Oklahoma from the 2015 wine crush. This winery processes their own grapes and also purchases grapes from various Oklahoma vineyards. We will record the grape cultivar(s) being processed and the location in Oklahoma from which they were sourced to help in identification of any location-and cultivar-specific differences we observe in seed product handling and quality. Grape seed oil and flour products will be produced and packaged as described in objective 1 and quality/nutritional components will be assessed as outlined in objective 2.

All studies will be conducted in an appropriate and replicated statistical design to allow sound interpretation of the results; oil and flour will be blocked according to grape variety (or varieties if mixed varieties are processed) and use for white (no pomace fermentation) or red (pomace exposed to fermentation) wine production. Third party nutritional analyses will be conducted for representative white and red grape products.

<u>Objective 1: Optimizing a system for oil and meal production and packaging.</u> Under this objective we will combine steps 1-5 identified in figure 1 with product packaging to initiate marketing of the new Oklahoma products. In collaboration with Robert M. Kerr Food and Agricultural Products Center marketing specialists we will assist Redbud Farms in development of their signature label for the products and package a pilot batch of product for test marketing and hopefully for inclusion in promotional programs such as the Made in Oklahoma program.

Optimization of the system steps: Hand crank operation of the pomace breaker/feeding mechanism on the pomace seed separator (step 1 in fig. 1; fig. 2) has allowed us to evaluate the mechanism and verify its functionality for evenly feeding clump-free pomace to the rotating cleaning screen. We have found

Figure 2. Hand crank pomace breaker/feeding mechanism. Motor placement at the crank brace is requested to correct uneven cleaning screen pomace delivery and decrease operator fatigue.

excellent functionality for the mechanism but the hand crank feature required the operator to halt pomace loading while hand cranking – this load-then-crank operation led to uneven feeding of the rotating cleaning screen and inefficiency in the seed separation process. Operator fatigue was also noted contributing to lags in pomace loading and feeding to the rotating cleaning screen. We propose to replace the hand crank with a small speed controlled electric motor. This motor could be actuated with a foot pedal for hands free/variable speed operation or motor speed may be hand-dial controlled similarly to the speed control of the cleaning screen. This improvement should streamline the pomace separation process, preventing a bottleneck at this initial operation and perhaps improve seed separation efficiency. It may also contribute to prevention of a fatigue-related accident and thus enhance the safety of this part of the grape seed production system.

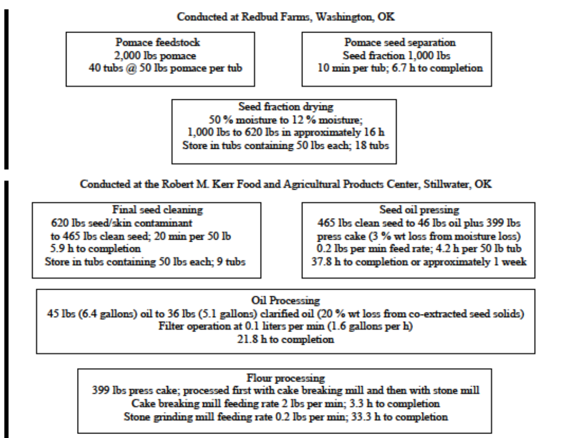


Figure 3. Material flow and critical operational parameters for a small scale (1 ton pomace per day maximum capacity) grape seed products system.

The remaining steps in the seed processing system (steps 2-5 in fig. 1) will be assessed for function within the system, with material flow as predicted in figure 3. Pomace will be transferred from Canadian River Winery in Lexington, OK to Redbud Farms in Washington, OK (6 miles) and the initial pomace seed separation and seed fraction drying will occur at Redbud Farms. Once the seed fraction is dried to 12 % moisture it is stable for storage up to 5 months. The seed fraction will be transferred for completion of processing at the Robert M. Kerr Food and Agricultural Products Center where final seed cleaning, seed oil pressing and oil filtration/presscake milling will be conducted. From a 1 ton batch of grape pomace we estimate that just over 5 gallons of grape seed oil and just under 400 lbs of grape seed flour can be produced. This project is focused on combining the steps outlined in figure 1 into an interactive system outlined in figure 3, and accomplishing improvements in operation which increase throughput and/or lead to increased quality of the final products, as defined in objective 2. Once the processing system is adjusted for efficiency and final products of clarified oil and flour are considered representative and reproducible, we will ship samples of products for nutritional analysis by a third party commercial laboratory for final verification of nutritional labeling of the new Oklahoma products.

While the nutritional label is an important required portion of the overall product label, Redbud Farms will also need to develop an eye-appealing logo and descriptions which set their products apart, and package the oils and flours in containers which impart value to the products. The Robert M. Kerr

Food and Agricultural Products Center houses multiple staff who specialize in food product marketing and who can assist with these activities. Our request for packaging supplies is for a small quantity of the style of package(s) arrived at by their interaction with Redbud Farms owners Terry and Susan Boehrer to allow production of a small trial batch of product for market testing (and hopefully inclusion in promotional programs such as Made in Oklahoma, etc.). The pilot processing area of the Robert M. Kerr Food and Agricultural Products Center commonly hosts such activities to stimulate growth of Oklahoma's food processing industry – directly in concert with this project.

Objective 2: Analytical product assessments: This work will be necessary to assess and document "best" system improvements, based on quality of the products. In all cases we will document initial quality and phytochemical content (oil content, total phenolic content, monomeric phenolic/anthocyanin content, moisture content, bulk desity) on each batch of product after the final seed cleaning step (step 3 in figure 1), and at each stage of the process.

a) Grape seed oil analyses: Grape seed oil content will be assessed via a long standing ether extraction protocol in the PI's lab. A representative sample of grape seed (and of grape seed presscake, broken presscake and presscake flour) will be ground with a Wiley and UDY mill to produce a fine powder. Aliquots of 200 mg will be accurately weighed and extracted four times with 4 ml of ether. Ether will be evaporated and oil content will be assessed gravimetrically. Oil solids content and wax content will be assessed for pressed oils. An oil sample (10 to 50 gm) will be accurately weighed into a centrifuge tube and centrifuged at 70 ^{o}F at 20,000 g for 20 min to remove any particulate contamination. The oil will be decanted into a second tared centrifuge tube to await winterization and the pellet will be extracted three times with ether to remove residual oil, and then dried and weighed to determine oil solids content. Winterization will be tested by placement into a cold room (34-40 ^{o}F) for one to two weeks. Oil will then be centrifuged as above and quantitated gravimetrically, against a paired non-refrigerated control oil sample. Oil fatty acid content will be assessed as fatty acid methyl esters as described by Kanamangala et al. (1995), oil sterol content will be assessed according to a standard lab protocol and smoke point will be assessed according to standard procedures.
b) Grape seed/presscake and presscake flour phenolic analysis: Phenolics will be analyzed as monomers by HPLC and total phenolics will be assessed using the Folin-Ciocalteu procedure and expressed in gallic acid equivalents (GAE) as described by Luque-Rodriguez et al. (2007). Oligo- and polymeric phenolics will be determined from total phenolics minus monomeric phenolics. We will use the procedure of Ramirez-Lopez (2011) to extract, separate and quantitate monomeric phenolics from the samples. This procedure will also allow simultaneous separation and quantitation of anthocyanin and non-anthocyanin phenolics and will be used for both anthocyanin and monomeric phenolic analytical determinations. Briefly, samples will be extracted with acidified methanol (0.1 M HCL), deglycosylated and the extract will be analyzed by reverse phase HPLC using a Sunfire C-18 column and diode array detection (DAD). Peaks will be identified according to UV spectra and co-elution with authentic standards and quantified using 7-ethoxycoumarin as internal standard.
c) Moisture content: Grape seed, grape seed press cake and grape seed flour moisture contents will be assessed by oven drying at 160 ^{o}F to a constant weight. Grape seeds from fresh pomace separation will be assessed as-is, after drying and after seed cleaning of the dried seed to determine moisture content of each fraction. Moisture content of pomace non-seed components (skins, residual pulp, stems) will also be determined to calculate a mass balance for the process.
d) Nutritional labeling: Covance laboratories offers a "Mandatory Food Labeling Package" which includes assessment of all nutrients required to develop a nutritional label – we request funding here to run duplicate samples representative of our final processing system of white and of red grape seed flour and a single sample of grape seed oil from the red and from the white grape seed. The package includes proximate analysis of moisture, ash and protein, calories, calories from fat, total fat, cholesterol, total carbohydrates, total dietary fiber, sugars, Vitamins A and C, calcium, iron and sodium.

Commercial Application and Implications: Our work to date has attracted serious commercial interest from Terry and Susan Boehrer, proprietors of Redbud Farms in Washington, Oklahoma to produce and market grape seed products derived initially from Oklahoma winery pomace and eventually to operate as a regional processor utilizing pomace from neighboring states to expand their Oklahoma business. During 2013 the Boehrers obtained a rotary seed cleaner; we identified key deficiencies for the cleaner and in 2014 we modified an identical cleaner to overcome the shortcomings of the original cleaner and utilized it for the 2014 grape crush with great success. The Boehrers have also built seed dryers with sufficient capacity to accommodate their small scale enterprise. The work proposed here is focused on new product delivery to market, providing a system for production of grape seed products on a scale which is appropriate for profitable operation of an Oklahoma enterprise. Refinements of our system will be quality conscious and mindful of two important features of the operation which affect profitability: 1) cost of production of the new products and 2) value of the new products. Because we are modifying equipment within a system sized appropriately for the Oklahoma wine grape industry, we expect the equipment configurations and settings for optimized protocols to be directly transferable to the commercial process; equipment costs should also be readily determined for an Oklahoma enterprise and expected maintenance and operation costs should also be readily determined. Our efforts to conduct selected quality analyses of the products will be complemented by economical third party determination of required nutritional label information as a critical step to bring the new products to market. Marketing specialist assistance to properly package and convey product identity is a final critical component of this project to launch the new products into commerce. **Our project is sharply focused on gaining greater value from Oklahoma grapes – while it does not address grape production issues or improvements in wine production from grapes, it does address a currently unutilized source of income from Oklahoma grapes which could enhance the overall profitability and commercial presence of our Oklahoma viticulture industry.** Redbud Farms already accomplishes the first two steps in our small scale pomace processing system. Our pilot processing work in Stillwater is necessary to fine tune the grape seed processing system and provide initial product for market evaluation. It also accommodates training in use of the required processing equipment and suggests the size and layout for a facility to be built to accommodate the food handling components of a new grape seed products enterprise. Our proposed work is targeted to fill any remaining technology gaps to provide a complete grape seed handling system on a scale that makes sense for an Oklahoma enterprise - we believe the chances of launching a successful new Oklahoma business are excellent and thus precisely appropriate for funding via the Oklahoma Viticulture and Enology Fund.

Project Economic Impact: The potential dollars generated from grape seed utilization on a state-wide basis are briefly detailed in the introduction, with income streams from a current waste product ranging from about $376,377 to over $925,000 per year, based on an estimate of Oklahoma grape production. While it is unrealistic that every Oklahoma grape seed would be used for this enterprise, it is realistic that grape pomace from neighboring states could be utilized as a secondary source of seeds to support the enterprise, easily growing beyond the potential presented by Oklahoma alone. Our intent is to provide a system for small scale value added grape seed processing – not by miniaturizing equipment common to the large-scale industry but by modifying or otherwise identifying available equipment to fit the smaller scaled enterprise and demonstrating their use as part of a processing system. Our equipment costs of $39,050 can fit the income stream estimates above nicely.

Our project converts a current waste stream, which carries a cost for disposal and which could have negative environmental impacts, into an income stream for the Oklahoma viticulture industry. Although not addressed in our proposed work, the non-seed pomace components are being used for animal feed, at a level of 10% replacement of conventional feed ingredients. At ½ the weight of our industry's pomace, this represents 74 tons (wet weight) of feed replacement for added value of the enterprise. This product is dried from approximately 60 % moisture to 15 % moisture for stable storage, reducing the weight to almost 41 tons of feed; with cottonseed meal at a current price of $355/ton, the added value of the pomace by-product is $14,555 if considered an extender for cottonseed meal.

Budget:

Salary (Technician)	
Salary	$21,126
Fringe benefits	$9,323
Hourly student worker	
Salary	$4,000
Fringe benefits	$110
Total Salary/benefits	$34,559
Equipment	
Pomace breaker/feeding mechanism motor	$1,100
Rotary seed cleaner modifications	$400
Supplies	
GC column	$520
GC supplies	$400
HPLC columns and precolumns	$1,340
HPLC supplies	$400
Spectophotometer supplies	$400
Standards	
Anthocyanins/phenolics	$2,300
Oil and flour packaging	$600
Mandatory Food Labeling analysis	$6,315
Sample shipping for analysis	$250
Travel to obtain and process pomace	$1,400
Total request	$49,984

Budget Justification:

The budget is for one year and was prepared in accordance with Oklahoma State University. Salary for support personnel is for partial support of Donna Chrz, Senior Research Specialist, and includes 58% coverage of 12 months of salary ($21,126) and fringe benefits (university negotiated rates are 44.13 % of base salary; $9,323). A portion of Ms. Chrz salary and fringe benefits (42%) is covered by the Oklahoma Agricultural Experiment Station. Ms. Chrz will be responsible for directly participating in and overseeing seed processing and product packaging operations slated for Stillwater, as well as the analytical work identified in objective 2. We also request funding for 1 hourly student worker for salary ($4,000) plus fringe benefits (university negotiated rates are 2.74 % of base salary; $110) to primarily assist with the seed oil pressing and oil clarification/flour production aspects in objective 1 and the in-house analytical work in objective 2.

Dr Niels Maness is the PI on this project. He has over 18 years experience in extraction science of various fruit, vegetables, herbs and nuts, almost 30 years experience in analytical methods development, and specializes in harvesting, handling and processing systems to add value to specialty crops in Oklahoma. He has experience in working with various extraction companies and their processes, and in scaling up and specifying equipment for commercial processes, in order to transform pilot data into commercial systems. He will be primarily responsible to assist with the initial pomace/grape seed handling steps to be conducted at Redbud Farms and to oversee activities in grape seed processing, packaging, and analytical assessments of the products. He will be responsible for transmitting samples for “Mandatory Food Labeling” analyses and will assist in converting the data into the product nutritional labels. He is fully capable of conducting the work described here and using the results to assist Oklahomans in design and customization of small scale commercial systems for grape seed oil production and by-product utilization.

Dr. William McGlynn is Co-PI on this project. He has over 16 years experience in horticultural crop food processing and manages the enology lab at the Robert M. Kerr Food and Agricultural Products Center at Oklahoma State University. Dr. McGlynn will oversee the packaging and assist with design of labels for the new products. His laboratory facilities will host the anthocyanin/phenolic analytical work. His connection with the Oklahoma viticulture industry, and primary extension appointment at Oklahoma State University, will be key educational and technology transfer components for this project, and continued industry assistance following completion of this project.

Dr. Tim Bowser is also Co-PI on this project. He has over 21 years experience in food engineering and extensive experience in process scale up for food manufacturing. Dr. Bowser will be responsible for overseeing the modification to the rotary seed cleaner outlined in objective 1. No salary funding is requested for the PI or Co-PI's as their activities are well within their funded job responsibilities within the Departments of Horticulture and Landscape Architecture and Biosystems and Agricultural Engineering, and the Robert M. Kerr Food and Agricultural Products Center at Oklahoma State University.

Equipment requested here is for a variable speed motor and speed control ($1,100) for the pomace breaker/feeding mechanism previously developed for the rotary seed cleaner. We also request funding to offset material costs for installation of the motor ($400). All other equipment for grape seed processing is on hand and available for use by this project.

Supplies are categorized as GC columns (one DB-23 for oil fatty acid analysis; an existing DB-5 column will be used for phytosterol analyses; $520), GC supplies (bottled gases, connectors, etc., $400), HPLC columns and precolumns (Anthocyanins/phenolics: Waters Sunfire C-18 column, $820 and precolumn to protect the analytical column, $520), HPLC supplies (various solvents, autosampler vials, paper for printing chromatograms, etc.; $400), spectrophotometer supplies (Folin-Ciocaltea reagents, cuvettes, etc.; $400), a magnitude of standards for anthocyanins/phenolics ($2,300) and various container sizes for initial packaging of the new oil and flour products ($600).

Our request also includes funding for 6 "Mandatory Food Analysis" offered by Covance Laboratories, Inc. for nutritional assessments of the final grape products, including duplicate runs for red and for white grape seed flour and individual runs for the oil from them. These runs include all nutrients, with sugars assayed by HPLC, minerals by ICP and total fat as the sum of fatty acids calculated as triglycerides. These analyses are essential for confirming information required for the nutritional facts label which must accompany the new Oklahoma food products. The package of analyses are offered for $1,052.50 each; our total request for 6 samples is $6315, plus $250 to cover shipping of the samples.

Travel requested here is to cover vehicle rental for in-state travel to support visits to the winery to obtain pomace samples for extraction studies, to assist with the initial steps in the system to be conducted at Redbud Farms and to transport product to Stillwater for completion of processing ($1,400).

All major analytical equipment and additional pilot equipment not requested here is available for use by this project on campus at Oklahoma State University to conduct the experiments outlined in this proposal. If necessary, wine grapes can be obtained from the experimental vineyard at the Oklahoma Agricultural Experiment Station Cimarron Valley Research Station in Perkins, Oklahoma to support expanded studies.