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Survey of US fuel ethanol plants

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ABSTRACT

The ethanol industry is growing in response to increased consumer demands for fuel as well as the renewable fuel standard. Corn ethanol processing creates the following products: 1/3 ethanol, 1/3 distillers grains, and 1/3 carbon dioxide. As the production of ethanol increases so does the generation of its coproducts, and viable uses continually need to be developed. A survey was mailed to operational US ethanol plants to determine current practices. It inquired about processes, equipment used, end products, and desired future directions for coproducts. Results indicated that approximately one-third of plant managers surveyed expressed a willingness to alter current drying time and temperature if it could result in a higher quality coproduct. Other managers indicated hesitation, based on lack of economic incentives, potential cost and return, and capital required. Respondents also reported the desire to use their coproducts in some of the following products: fuels, extrusion, pellets, plastics, and human food applications. These results provide a snapshot of the industry, and indicate that operational changes to the current production of DDGS must be based upon the potential for positive economic returns.

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1. Introduction

The increased demand for ethanol as a fuel source has amplified the need to find valuable uses for coproducts of the process. Thus, ethanol processing and its co-derivatives are currently the source of many research investigations. At the beginning of 2008, the United States expected to produce approximately 7.2 billion gallons of fuel ethanol utilizing 134 manufacturing plants. Currently, another 77 plants are under construction or expansion, which will be able to produce an additional 6.2 billion gallons of ethanol. When all plants are operating, a total of 211 plants will produce 13.4 billion gallons of ethanol annually (RFA, 2008).

Currently, coproducts such as distillers dried grains (DDG) and distillers dried grains with solubles (DDGS) are predominately used to provide nutritional value to the diets of livestock. DDG is a good source of crude fiber (13%) and protein (27–30%), but is low in total carbohydrate (46%) (Miron et al., 2001; Al-Suwaiegh et al., 2002; Davis et al., 1980). The nutritional content of DDGS, however, can vary more, containing 5–11% crude fiber, 27–34% protein, 5–6% starch, and 39–62% carbohydrates most of which is neutral detergent fiber (UMN, 2007; Belyea et al., 2004; Spiehs et al., 2002; NRC, 1998, 1982). The high nutrient (especially protein and energy) content allows these coproducts to be an excellent feed for animal diets. It also appears that ethanol coproducts may be viable ingredients for human foods (Rosentrater and Krishnan, 2006; Saunders et al., 2008).

The purpose of this study was to survey US ethanol plant managers about current production practices. The survey was used to acquire information about processes, equipment used, end products, and desired future directions for their coproducts. Responses and suggestions offer a glimpse of current industry needs.

2. Methods

A contact list was obtained through the Renewable Fuels Association website, which is freely accessible to the public (RFA, 2008). At the time of this study (early 2007), 111 ethanol biorefineries were available and operating at full capacity. Of those, 94 were included in the survey, while the remaining 17 plants were excluded from the survey because those plants' primary feedstock was not corn (i.e. barley, cheese whey, brewery waste, or sugars). An additional 75 plants under construction and 8 plants under expansion were also excluded from this survey as construction precluded coproduct production.

Four main categories in the survey contained 15 questions: processing issues, potential food applications, future research, and nutritional information. The self-administered survey was delivered through the US Postal Service and was designed to take no more than 5–10 min to complete. Returned surveys contained no identifying information unless the respondent voluntarily enclosed plant coproduct nutrition information. Respondents were also offered the opportunity to receive a final copy of this paper upon

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completion if desired, therefore voluntarily provided name, address, and/or email address as contact information. Assigning numbers to surveys in the order returned maintained confidentiality (1–23). The survey was reviewed and approved by the South Dakota State University Human Subjects Committee. It was determined that this survey did not fall under the federal regulations for human subjects' research. The original cover letter and survey tool are located in Appendices A and B, respectively. The survey was mailed out (*n* = 94) in March of 2007 to ethanol biorefineries with a stamped, return envelope provided to facilitate participation. All responses identified were kept confidential, and only used for the purpose of data analysis. Data was summarized using Microsoft Excel (v.2003) to calculate mean values. To facilitate data analysis, a value of 1 or 0 was assigned to responses for questions which required a "yes" or "no", respectively.

3. Results and discussion

Data analysis was completed on a question-by-question basis, as some returned surveys were missing data (i.e. not all surveys were completely filled out). No follow-up surveys were sent; therefore 23 out of 94 surveys were returned resulting in a response rate of 24.5%. Response rates of 30% from mail surveys are often considered "satisfactory" (Cooper and Schindler, 2003).

3.1. Processing Issues

3.1.1. Quantity generated (n = 23/23 responses)

A wide variety of ethanol plants were surveyed, thus resulting in a range of coproduct production rates. The minimum and maximum amounts reported were 9200 and 390,000 tons per year, respectively. The average for the survey data was 131,205 tons per year, while the median value was 74,000 tons per year; 52.2% of respondents indicated coproduct production less than 99,999 tons per year, 26.1% indicated between 100,000 and 199,999 tons per year, and 21.7% indicated greater than 200,000 tons per year. Coproduct generation values can indicate ethanol plant size and production capacities.

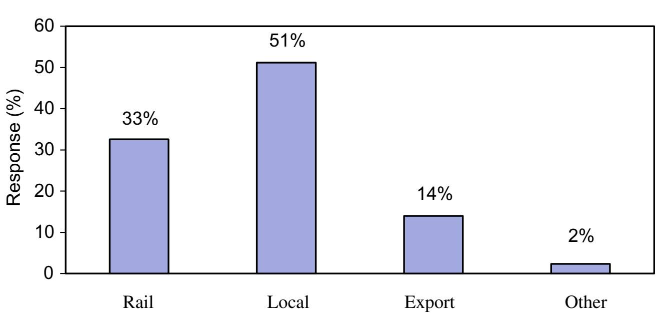

Fig. 1. Coproduct destination and transportation options currently used in industry (*n* = 23/23 responses). Note that rail denotes transportation for domestic DDGS use, whereas export denotes international shipment.

3.1.2. Coproduct destination (n = 23/23 responses)

Fig. 1 shows the distribution of destination and transportation method for coproducts among the following categories: ship by rail (for domestic use), export (i.e. international use), local animal feed, and other. Many survey respondents indicated more than one option for coproduct use after ethanol production at their particular plant. These data revealed that use for local animal feed (51%) was the most popular use of these coproducts, thereby benefiting local and surrounding communities. Golden LYK mineral blocks were a method identified in the "other" category, as a novel use for ethanol coproducts.

Rural economies are greatly benefiting from the ethanol industry in general, and coproducts in particular, as responses showed that many local farmers utilize this feed material. But an increasing amount of coproducts are being transported greater distances for final use (Rosentrater, 2007).

3.1.3. Typical deviations in chemical and physical characteristics (n = 23/23 responses)

Plant managers then identified various chemical and physical irregularities found in their coproducts. This information will allow researchers to classify areas that are increasingly problematic, and can be used to guide future research, that can ultimately benefit production practices. Fig. 2 categorizes the various deviations among US plants. The majority of respondents (51%) indicated that little variation was typically found in their coproducts. Other reported variations included color, burned coproducts, size of coproducts, quantity produced, soluble (i.e. CDS, or syrup) concentration, protein, and moisture. Less common deviations identified in the "other" category indicated were oil content and sulfur levels.

The identification of coproduct deviations was valuable, as these can be considered current weaknesses of the industry, or at least areas that could benefit from improvement. The need for uniformity in coproducts is great, as it impacts potential sales (Rosentrater and Krishnan, 2006). This is especially important when pursing value-added uses for coproducts, as well as using their use in animal feeds.

3.1.4. Dryer type (n = 23/23 responses)

One particular element that can greatly impact coproduct quality is the drying process. Fig. 3 shows the distribution of dryer types. An overwhelming 87.5% of ethanol plants surveyed utilized

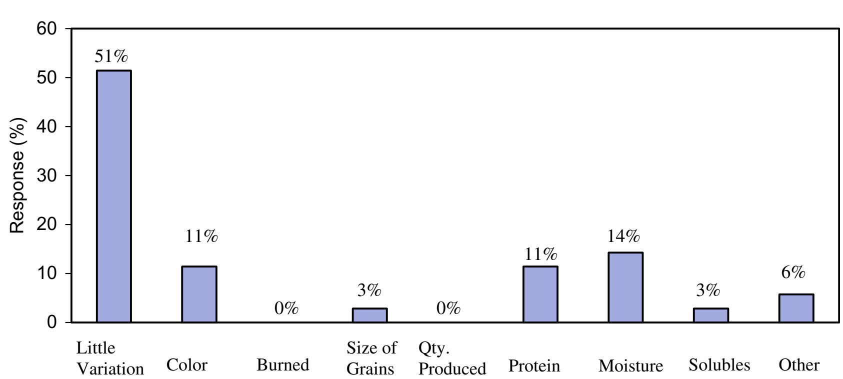

Fig. 2. Typical variations noted in coproducts (*n* = 23/23 responses).

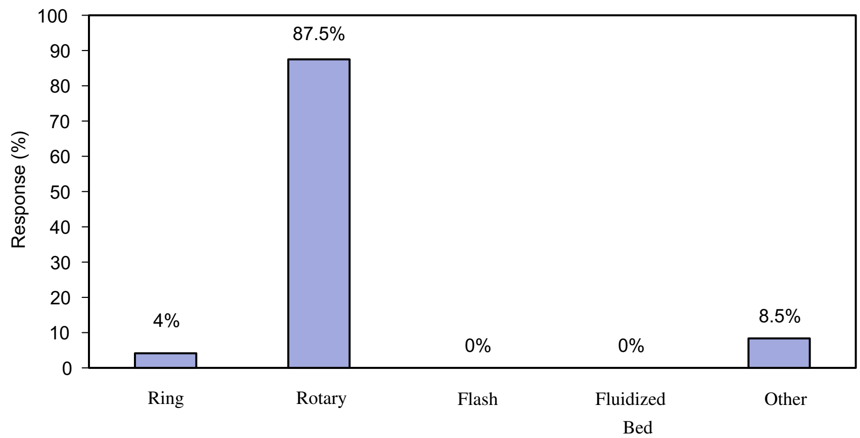

Fig. 3. Types of dryers used by ethanol plants ($n = 23/23$ responses).

rotary dryers. A few respondents indicated the use of more than one dryer type. Other drying methods (identified by the respondents via the "other" open response category) included heat, no natural gas burner, and coproducts that were not dried (i.e. no dryer used) – unfortunately, no additional explanation was provided with the survey responses. Drying methods and equipment play key roles in coproduct quality. Even though the rotary type dryer is heavily used in industry, this does not necessarily mean that it is the best type of dryer for all potential applications. Improved quality is necessary for future products, and dryer performance is an issue that should be examined more closely.

3.1.5. Typical drying times (n = 15/23 responses)

It should be noted that the term "dry" is very dependent upon each plant, and the moisture contents of the coproducts varied among the plants; all moisture contents were below 14%, however. More about this will be discussed subsequently. Drying times were pooled and analyzed by frequency distribution (Table 1). Average drying time was 0.85 h, with a standard deviation of 0.48 h. Most plants dried their coproducts less than one hour. If temperatures were reduced and/or optimized, perhaps higher quality coproducts could result. The nutritional quality may vary depending on grain type and processing methods (Dawson et al., 1985). Excessive exposure to heat can cause undesired Maillard browning within a material (Bertram, 1953). Coproducts need to be processed to fit consumer expectations. Drying time alone is not a good indicator of quality, as drying temperature also needs to be considered.

3.1.6. Plant manager willingness to alter drying time (n = 22/23 responses)

Responses regarding changes to drying time were similar to the above question, except some plant managers indicated hesitation to altering drying time. Fig. 5 shows the distribution of respondent's answers. Thirty-one percent of respondents stated they would possibly alter drying time and reported the following responses open-ended: "capital required and payback time frame"; "cost and return on investment"; "would alter by 15 min";

Table 1
Typical drying times used by ethanol plants for coproduct production ($n = 15/23$ responses).

Time (h)	Number of responses
<1	10
1–2	2
2–24	3
>24	0
Total	15

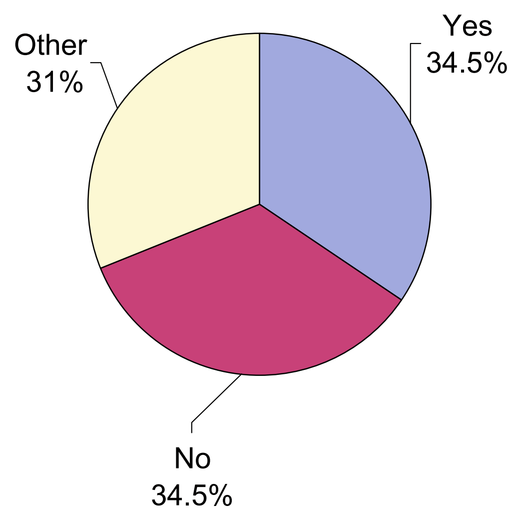

Fig. 4. Plant manager willingness to alter coproduct drying temperature ($n = 22/23$ responses).

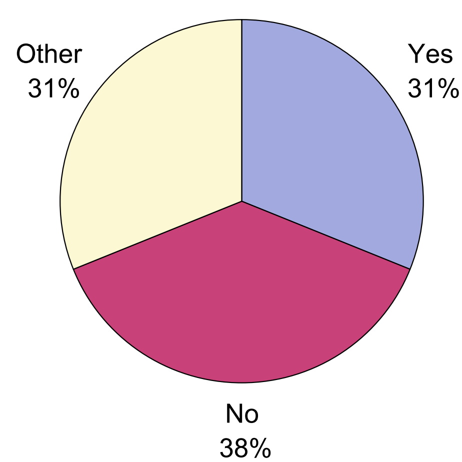

Fig. 5. Plant manager willingness to alter coproduct drying time ($n = 22/23$ responses).

"depends on economic incentive"; "only would shorten required time"; "depends on restriction of capacity". Thirty-eight percent of respondents stated they would not be willing or be able to change drying time. Lastly, 31% of respondents stated that "other" reasons that would influence their willingness to change included profitability.

3.1.7. Typical drying temperatures (n = 13/23 responses)

Drying temperatures were analyzed in two different processing locations: discharge and air temperatures. Frequency distributions illustrate the reported discharge temperatures in Table 2, and air temperatures in Table 3. Discharge temperature referred to the temperature of coproducts at the completion of the drying period. Air temperature, on the other hand, referred to the temperature of the drying air in the dryer. Discharge temperatures were approximately 90–100 °C, while air temperatures were on average, greater than 350 °C. The average discharge temperature was 99 °C with a standard deviation of 9 °C. Temperatures must be sufficient to uniformly dry the coproducts, but not too high, as that could cause undesired browning and protein denaturation. In fact, product temperatures as low as 50 °C have been shown to denature corn proteins (Weller et al., 1987; Wu et al., 1997). Lower drying temperatures would require the coproducts to be dried for longer periods of time, and vice-versa. An optimization of drying temperatures, along with appropriate drying times, may enhance coproduct quality; however, this is an area for future research by others.

3.1.8. Plant manager willingness to alter drying temperature (n = 22/23 responses)

One objective of this survey was to determine the level of willingness that each plant manager had in creating a higher quality coproduct. Fig. 4 shows the distribution of respondent's answers. One-third of the respondents reported a potential willingness to alter current drying temperatures and gave the following open-ended question responses: "depends on what it takes to increase quality"; "cost vs. return on investment"; "depends on what quality factors we are looking for"; "we do this currently"; "economic incentive"; "our goal is to manufacture consistent quality therefore if this helps us meet our goals then we will do it"; "will increase by another 50 °C"; "depends on restriction of capacity". On the other hand, one-third of respondents reported that they would not be willing or be able to change drying temperature, the following responses were received: "not possible", "our plant shoots for 12.5% moisture". Finally, 5% of respondents answered the "other" category, where they each indicated the desire for profitability. This insight should allow researchers to develop incentives necessary to motivate temperature changes to create higher quality coproducts, if indeed this type of modification could improve coproduct quality. To some extent, cooperation is a necessity among ethanol plants in order to correct weaknesses in the industry and create an increasingly uniform coproduct stream that is desirable by end users.

Table 2
Typical coproduct dryer discharge temperatures used by ethanol plants ($n = 13/23$ responses).

Temperature (°C)	Number of responses
80–90	2
90–100	6
100–110	4
>115	1
Total	13

Table 3
Typical drying temperatures used by ethanol plants for coproduct production (air temperature) ($n = 11/23$ responses).

Temperature (°C)	Number of Responses
200–250	0
251–300	1
301–350	1
351–400	2
401–450	2
451–500	2
501–550	3
Total	11

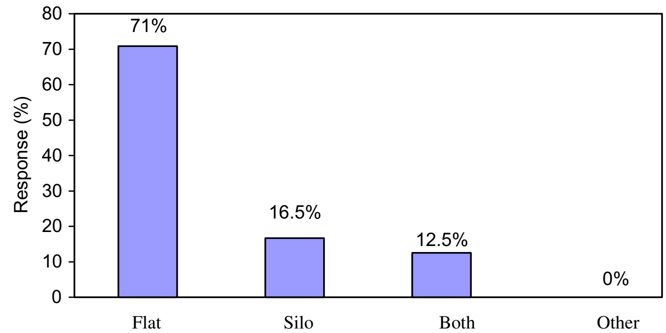

Fig. 6. Typical storage methods used in industry for coproducts ($n = 22/23$ responses).

3.1.9. Storage practices (n = 22/23 responses)

Fig. 6 illustrates the division of storage facilities that are currently used for coproducts by the companies surveyed. The majority of ethanol plants (71%) utilized flat-type storage structures. Approximately 12.5% of ethanol plants reported the use of two types of storage methods for coproducts (flat and silo). The enormous amounts of flat storage are a function of the fact that the majority of plants are smaller. The larger plants, on the other hand, typically use silo storage to boost space utilization.

3.1.10. Curing time (n = 16/23 responses)

Curing is a common practice, where materials are placed in piles in flat storage buildings, which allows them to cool after being dried. The average curing time for coproducts currently utilized in US ethanol plants was 0.93 days, with a standard deviation of 0.57 days. A range of 0–2 days was reported, which indicated that some plants do not use curing practices, but rather move coproducts directly into storage or ship the DDGS directly.

3.2. Potential food applications

3.2.1. Food grade quality coproducts (n = 22/23 responses)

Perhaps in the near future, coproducts can be integrated into the human food supply. However, it is only currently used to feed livestock. Of the ethanol plants surveyed, no plants reported to produce human food grade coproducts. The majority of ethanol plants (63.5%) surveyed do not produce food grade distillers grains (Fig. 7). Many managers (32%) are unsure of the specific qualifications required for a material to be classified as food grade. This information is extremely valuable, as it indicates the need for industry education regarding the specifications that must be met in order to classify materials as food grade. This knowledge will allow plant managers to decide if their plants can currently complete these requirements, or if additional equipment and/or training are necessary, or even affordable.

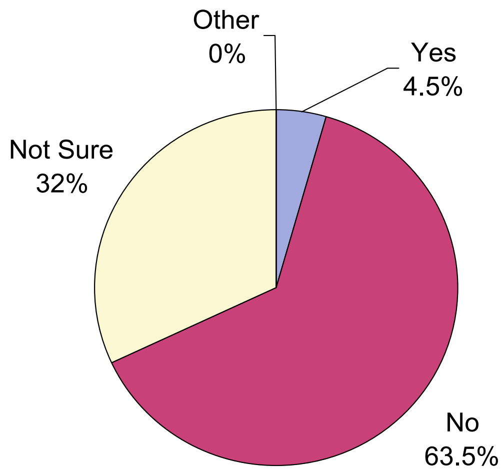

Fig. 7. Percentage of plants that currently produce food grade coproducts ($n = 22/23$ responses).

3.2.2. Plant manager willingness to create food grade coproducts ($n = 21/23$ responses)

Responses to this question indicated that the majority (62%) of ethanol plant managers would like to create a food grade coproduct (Fig. 8). This modification could add value to the ethanol production process, and may economically benefit the plant and surrounding communities. The remaining 38% of managers indicated that switching to a food grade coproduct might not be appropriate or cost effective for their current plant situation. Issues raised by managers when contemplating the potential to become food grade included the following responses: cost and payback; elimination of the use of antibiotics; switching from urea to a food grade nitrogen source; re-engineering dryers to make them fit for food grade coproducts; prices and values; profitability; economic incentive; requirements to become food grade.

3.3. Future research

3.3.1. Potential product applications ($n = 8/23$)

A summary of the respondents' open suggestions for potential uses for coproducts is listed in Table 4. All suggestions appeared to be feasible; however, additional research will be needed for many of these ideas. Limited research has been done on value-added coproduct applications besides livestock feed and potential human food ingredients. For example, a few studies have examined using ethanol coproducts as fertilizers (Erdem and Ok, 2002; Ramana et al., 2002a,b), biofillers in plastics (Tatara et al., 2007, 2009), and substrates for bioenergy (Rosentrater et al., 2006).. All of these options provide additional routes for coproduct utilization.

Table 4
Individual open responses to future product applications for coproducts ($n = 8/23$).

Responses
Combustion as a fuel source
Construction/building materials
Corn oil to bio-diesel and corn oil markets
Develop pet food, human food, and higher value markets
DGHP (high protein products)
Extrusion aquaculture
Fertilizer
Fluid bed combustion to replace or reduce natural gas and for electrical usage
Plastics and polymers
Pelletizing
To make pressboard, as glue is what holds the wood fibers together to make that product
Used more in animal feeds or non-ruminant feed

3.3.2. Issues limiting value and utilization ($n = 14/23$)

Another objective of this study was to identify limitations (Table 5) of coproduct production processes. Many important issues and roadblocks were identified by the respondents hat need to be addressed to help this industry move forward. These responses are reflective of Rosentrater (2007) which discussed many similar themes regarding the value and utilization of distillers grains, both from the ethanol production standpoint, and from a livestock feeding perspective, including the large quantities of energy required to remove water coupled with the high cost of energy; moving DDGS to diverse and distant markets when there are fluctuations in supply and demand; how to avoid mycotoxin contamination;

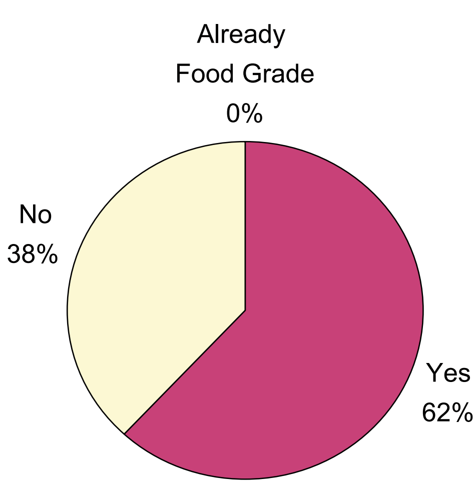

Fig. 8. Plant manager willingness to alter processes in order to produce food grade coproducts ($n = 21/23$ responses).

Table 5
Individual open responses to current issues limiting the value of coproducts ($n = 14/23$).

Responses
Customs or knowledge
DDGS industry is/has been black-eyed because of all the plant-to-plant differences
Farmer education
Fat solubles
Fiber content
Fiber restricting use in poultry and swine
Flowability
If sulfur could come down modified, customers could use higher substitution rates
Lack of research for some livestock species
Markets for products to capture true value of coproducts
Need to develop a system in which we can all understand or at least recognize these differences and how they impact feed attributes
Our plant does almost 95% wet distillers grain
Oversupply
Reputation of consistent quality and education of feeders
Supply vs. demand
Swine use
Transportation costs getting higher
We will be gasifying the DDG for steam production and electricity production and the remainder to investor feeders

Table 6
Compilation of nutrient profiles for ethanol coproducts.

Plant number	Type of coproduct	Protein (%)	Moisture (%)	Crude fiber (%)	Acid detergent fiber (%)	Fat (%)	Ash (%)
2	DDGS	29.10	6.74			10.40	3.71
4	DDGS	27.90	10.88		9.91	11.80	4.14
16	DDGS	29.04	8.72	10.52	13.15	10.30	
19	DDGS	25.00		15.00		9.00	5.00
22	DDGS	26.00		15.00		10.00	6.00
	Averages	27.41	8.78	13.51	11.53	10.30	4.71
1	DDG	27.00	10.40	7.38	11.20	7.72	3.23
3	DDG	27.20	11.47		10.50	10.40	4.31
8	DDG	26.20	13.37	4.64	6.36	10.80	4.47
13	DDG	26.27	9.92	5.95	9.74	9.99	3.60
17	DDG	29.80	9.80		14.80	7.40	4.28
18	DDG	26.60	8.96	6.14	11.20	10.90	3.28
21	DDG	28.36	12.59		0.50		
23	DDG	22.96	13.38			10.14	23
	Averages	26.80	11.24	6.03	9.19	9.62	3.86
10	High Protein DDG™	43.00	7.80			4.30	2.10
11	High Protein DDG™	35.00	12.50	9.00		1.50	
	Averages	39.00	10.15	9.00		2.90	2.10
23	Wet DG	13.04	50.52			6.23	
17	Wet DG	16.00	51.10		6.90	4.60	2.22
	Averages	14.52	50.81		6.90	5.42	2.22
10	Corn Germ Dehydrated™	17.50	8.90			20.20	6.20
20	Golden Bran™	31.90	8.84	11.55		7.22	

variability in nutrient content, quality, and associated quality management programs, lack of industry-wide quality grading standards; inconsistent product identity and nomenclature; lack of education and technical support for the industry; and international marketing and export challenges.

3.4. Nutritional composition

3.4.1. Nutritional profile compilation (n = 16/23)

A majority (69.7%) of respondents provided nutritional information for their coproducts. Various nutritional profiles of DDG, DDGS, Wet DG, Dehydrated Corn Germ™, Golden Bran™, and High Protein DDG™ were provided, and are summarized in Table 6. Nutrient averages have been calculated according to nutrient profiles. Not all of the nutrient profiles that were returned with the surveys (i.e. provided by the plant managers) contained the same chemical properties (e.g., not all contained protein, moisture, fiber, acid detergent fiber, fat, and ash information); therefore, information not provided was indicated by a blank space in the table. DDGS protein ranged from 25% to 29%, moisture ranged from 7% to 11%, and fat ranged from 9% to 12%. DDG, on the other hand had protein that ranged from 23% to 30%, moisture ranged from 9% to 13% and fat ranged from 7% to 11%.

4. Conclusions

The ethanol industry requires useful avenues for coproducts in order to ensure profitability. Many new ethanol plants will be constructed in the next several years to help meet increased consumer demand and government requirements (RFA, 2008). This survey gathered information on processing systems, the willingness of plant managers to create food grade coproducts, future product ideas, and other current limitations of the industry. These insights will provide researchers with a starting point for developing products and processes that will add value and refine the ethanol production process.

Plant managers reported several promising ideas that could be pursued, including pelletizing; non-ruminate animal feed; fuel; high protein distillers grain products; pet and human food; extrusion for aquaculture feeds; construction and building materials; plastics; fertilizers; corn oil; and bio-diesel. All suggestions seem to be feasible; however, additional research will be needed. In fact, research has already begun on use of coproducts as fertilizers, biofillers, and bioenergy sources. All suggestions are valuable to researchers as they provide additional ideas for coproduct applications. Survey respondents were also asked to identify factors currently limiting the value of coproducts. Responses included: flowability; knowledge; farmer education; swine use; fat solubles; oversupply; reputation of consistent quality; increasing transportation costs; fiber content; fiber restricting use for swine and poultry; and supply vs. demand. The identification of weaknesses can facilitate research, which will ultimately help to optimize production processes.

Acknowledgements

The authors are grateful to the representatives of the US fuel ethanol industry who were willing to complete the survey and provide information about their processes and products. The authors also wish to thank P.G. Krishnan for providing supplies and postage with which to conduct the survey.

Appendix A. Cover letter which accompanied survey

Dear Plant Manager,

Would you be able to help me with a survey?

I am a Food Science Graduate Student at South Dakota State University currently enrolled in a Marketing Research course. The purpose of this research project is to survey ethanol production plants throughout the US on issues concerning the coproduct distillers grains. Your answers will enable researchers to better comprehend the ethanol production process, this in turn can be used to help design more efficient methods for plants, and ultimately add more value to the humble kernel of corn.

Your plant's name was part of an inclusive list of ethanol plants in the United States. Your answers are very important to the accuracy of my research.

It will take only a few minutes to answer the simple questions on the enclosed questionnaire and to return it in the stamped reply envelope.

Of course all answers will be confidential and will be used only in combination with all other returned questionnaire results.

If you are interested in receiving a report on the findings of this research, please write your name, address, or email address at the bottom of the questionnaire. I will be glad to send you a complimentary report when ready.

Please return the completed questionnaire by Monday, March 26th 2007. Thank you for your help.

Appendix B. Survey instrument used to gather information

PROCESSING

1) Approximately how much distillers dried grains (DDG)/ distillers dried grains with solubles (DDGS) does your plant produce each year (in tons)? ______________________(please indicate)

2) What does your plant do with the DDG/DDGS produced? (please check all that apply)
____ Ship by rail
____ Local Animal Feed
____ Export
____ Other (please indicate)_______________________

3) What typical deviations do you find among DDG/DDGS batches? (please check all that apply)
____ There is little variation at my plant
____ Color (yellow, orange, browns, etc)
____ % Burned
____ Size of coproducts kernel
____ Quantity produced
____ Protein content
____ Moisture content
____ Soluble content
____ Other (please indicate)________________________

4) What type of DG dryer does your plant use?
____ Ring Dryer
____ Rotary Dryer
____ Flash Dryer
____ Fluidized Bed
____ Other (please indicate) ________________________

5) What is your plant's typical drying time (in hours)? ______________ (please indicate)

6) What is your plant's typical drying temperature (°C)? ______________ (please indicate)

7) Would your plant be willing to alter drying temperature to increase quality of DDG/DDGS ?
____ Yes
____ No
____ Other
If Yes please indicate how much __________.

8) Would your plant be willing to alter drying time to increase quality of DDG/DDGS?
____ Yes
____ No
____ Other
If Yes please indicate how much __________.

9) What type of storage does your plant currently use for DDG/DDGS?
____ Flat
____ Silo
____ Both
____ Other (please indicate)_____________________

10) How much time does your plant allow for curing time (cooling time) of DDG/DDGS (in days)? ________________ (please indicate)

POTENTIAL FOOD APPLICATIONS

11) Currently, is the DDG/DDGS produced by your plant of food grade quality (meaning it qualifies under government regulations for use in food products?
____ Yes
____ No
____ I'm not sure
____ Other

12) Would your plant be open to the idea of altering current manufacturing processes to create a food grade DDG/DDGS?
____ Our DG is already food grade
____ Yes
____ No
If Yes, what changes would your plant be willing to make? ________________________

____

FUTURE RESEARCH

13) What potential product (food or non-food) applications would you like to see for DDG/DDGS? ____

____ (please specify)

14) What are the most important issues currently limiting the value and utilization of DDG/DDGS? ____

____(please indicate)

NUTRITIONAL

15) Please submit a typical nutritional profile for the DDG/DDGS produced by your plant on a separate sheet of paper.

Thank you for your participation. If you would like a copy of the final report utilizing these questionnaires results please provide the following information.

Name:
Address:
Email Address:

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