FPRF Technical Services Newsletter

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"Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world."

—Louis Pasteur

President's Column

Saying what you believe without documentation is not much better than just expressing an opinion or a point of view. As for scientific research, the results are often so contradictory that in many areas there is simply no consensus. In the natural sciences, the criterion of reproducibility is frequently easy to meet, but in some of the social sciences, the problem of achieving reproducibility often seems extreme.

Nevertheless, for the findings to be regarded as scientific, whoever publishes them must accept the trouble of presenting them in a manner that permits others to test them. The intent to be accurate or impartial is not what makes a discipline a science. Indeed, meticulous reporting or unbiased sampling is not the basis for scientific acceptance. Reproducibility is what ultimately counts. Outstanding results are often obtained by persons with a stake in a particular outcome. As such, academic scientists usually have a greater professional benefit to be gained from "positive" results than from "negative" results.

Can you trust the opinion of a scientist? Speaking as a scientist myself, I would say the answer is yes, no, maybe, maybe not, or it depends. From my own experience, scientists are human and suffer the same faults as all the rest of society. By all means, be cautious. As the new saying goes, "Do not believe all that you read on your email".

Sergio F. Nates, Ph.D.

Country Focus - Argentina (by Gianni Carniglia)

The Rendering Industry in Argentina is represented by forty companies all registered at SENASA. Other plants include poultry operations. About 60% of the production is concentrated among five companies. Similar to Brazil (Year 1 – Issue 3), a significant number of small plants exist without any type of registration. In 2005, the production of meals and fat from animal residues reached 700,000 metric tons. Data for 2006 has not been released, but the original expectations were of a significant increment.

Nevertheless, the situation has only been favorably in the poultry sector, while cattle production felt near 10%. Like in other Latin American countries, Biodiesel has become a new business opportunity for the Argentinean rendering industry.

Changes in government policies are being implemented and laws are in place to support the industry. It is expected that in 2007 these new norms will take effect so future projects can be regulated and plants monitored. The goal of the Argentinean government is that by 2010 a minimum of 5% in traditional fuels usage will come from renewable resources.

R&D Update (Progress report)

05B-1 **Comparative study on the capacity in utilizing rendered ingredients as dietary protein sources between fast-feeding and slow-feeding marine fish species**

Objectives: The objective of this project is to compare the capacity between malabar grouper (*E. malabaricus*) and cuneate drum (*Nibea miichthioides*), two commercially important marine fish species widely cultured in China, in utilizing rendered protein ingredients as fish meal substitutes in diets. Sub-objectives include:

1. Examine the potential of malabar grouper to use meat and bone meal (MBM), poultry by product meal (PM), feather meal (FM) and blood meal (BM) as fish meal substitutes in diets.
2. Compare the digestibility of malabar grouper and cuneate drum on MBM, PM, FM and BM, by vitro and invitro methods. To examine the relationships between feeding time and feed intake, and between feeding time and growth performance in malabar grouper and cuneate drum fed diets in which MBM, PM, FM and BM were included at various levels.
3. Examine the effect of adding some attractants such as meat solubles, squid meal, shrimp meal or synthetic amino acids in diets in which PM and BM were included at various levels on feeding time, feed intake, growth performance of malabar grouper and cuneate drum.
4. Examine the possibility to develop fish meal free diets for malabar grouper and cuneate drum using mixture of PM, BM and FM as animal protein sources.
5. Generate the information necessary for developing commercially practical diets for malabar grouper and cuneate drum cultured in marine net pens or cages in China.

Results:

Trial 1 (GF-1): Use of rendered animal protein ingredients as fish meal substitute in feeds for malabar grouper (*Epinephelus malabaricus*)

Survival of fish in the first feeding trial was 96.7±0.5% (mean ± SE, n=27). There was no significant difference in survival rate among the treatments ($P>0.05$). Feed intake was higher in fish fed the feed PM1, MBM2 and FM1, and lower in fish fed the PM3 feed, than fish fed the control feed ($P<0.05$). No significant difference was found in feed intake between fish fed the control feed and feed PM2, MBM1 and FM2 ($P>0.05$). Specific growth rate and final body weight was not significant different

among the fish fed the control feed and PBM 1-3, MBM 1-2 and FM 1 (P>0.05), and the fish fed the feed FM 2 had the lowest SGR and final body weight among the fish fed the formulated feeds (P<0.05). Feed conversion ratio was higher in the fish fed the feed MBM 2 and FM 1-2 than fish fed the control feed (P<0.05), while no significant different was found in FCR between fish fed the control feed and the feed PBM 1-3 and MBM 1 (P>0.05). Fish fed the feed FM2 had a lower NRA than that of fish fed the control feed (P<0.05).

There were no significant differences in CF among fish fed the formulated feeds (P>0.05). Fish fed the feed PM1-2 had a lower HSI, while fish fed the feed FM1 had a higher HSI, than that of fish fed the control feed (P<0.05). There were no significant differences in contents of moisture, protein, lipid and ash in whole body among fish fed the formulated feeds (P>0.05).

Fish fed the raw fish feed had lower feed intake, FCR, NRA and HSI, but higher SGR and final body weight than that of fish fed the control feed (P<0.05, Table 5 and 6). There were no significant differences in CF and whole body components between fish fed the raw fish feed and control feed (P>0.05).

Trials 2 and 3 (GF-2 and GF-3): Replacing fish meal with a blend of rendered animal protein ingredients in practical feeds for malar grouper (*Epinephelus malabricus*)

Survival of fish during the trial GF-3 and GF-4 was 92-98%, and there was no significant difference among fish in all the treatments (P>0.05). Feed intake was lower in fish fed the control feed than fish fed the feed AM3 and AM4 (P<0.05). Specific growth rate and FBW of fish fed the control feed were not significant different from that of fish fed the feed AM1 and AM2 (P>0.05), but higher than that of fish fed the feed AM3 and AM4 (P<0.05). Feed conversion ratio was higher in the fish fed the feed AM 3 and AM4 than fish fed the control feed (P<0.05), while no significant different FCR occurred between fish fed the control feed and the feeds AM 1 and AM2 (P>0.05). Fish fed the feed AM3 and AM4 had the lower NRE than that of fish fed the control feed (P<0.05).

No significant difference was found in feed intake between fish fed the control feed and feed AM1, AM2, SC, SAM3 and SAM4 (P>0.05), while fish fed the feed AM3 had highest feed intake among the treatments (P<0.05). Specific growth rate and FBW was not significant different among fish fed the control feed, feed AM2 and SC (P>0.05). Fish fed the feed AM3 had lower SGR and FBW than that of fish fed the control feed, and fish fed the feed SAM3 and SAM4 had lower SGR and FBW than that of fish fed the feed SC (P<0.05). Feed conversion ratio was higher in fish fed the feed AM3 and SAM3 than fish fed the control feed and feed SC (P<0.05). Fish fed the feed AM3 and SAM3 had lower NRE than that of fish fed the control feed and feed SC (P<0.05). There were no significant differences in SGR, FBW, FCR and NRE between fish fed the control feed and feed SC, and between fish fed the feed AM2 and SAM2, and between fish fed the feed AM3 and SAM3 (P>0.05). Fish fed the feed AM3 had higher feed intake than that of fish fed the feed SAM3 (P<0.05).

There were no significant differences in CF and HSI among treatments in the trials GF-2 and GF-3 (P>0.05). No significant differences in moisture, protein, lipid and ash contents in whole body were found among treatments in the trials GF-2 and GF-3 (P>0.05).

Trial 4 (GF-4): Apparent digestibility of cuneate drum (*Nibea miichthioides*) and malar grouper (*Epinephelus malabricus*) on various rendered animal protein ingredients

Survival of fish in the feeding trial was 96.7±0.5% (mean ± SE, n=27). There was no significant difference in survival rate among the treatments (P>0.05).

Feed intake was higher in fish fed the feed PM1, MBM2 and FM1, and lower in fish fed the PM3 feed, than fish fed the control feed (P<0.05). No significant difference was found in feed intake between fish fed the control feed and feed PM2, MBM1 and FM2 (P>0.05). Specific growth rate and final body weight was not significant different among the fish fed the control feed and PBM 1-3, MBM 1-2 and FM 1 (P>0.05), and the fish fed the feed FM 2 had the lowest SGR and final body weight among the fish fed the formulated feeds (P<0.05). Feed conversion ratio was higher in the fish fed the feed MBM 2 and FM 1-2 than fish fed the control feed (P<0.05), while no significant different was found in FCR between fish fed the control feed and the feed PBM 1-3 and MBM 1 (P>0.05). Fish fed the feed FM2 had a lower NRA than that of fish fed the control feed (P<0.05).

There were no significant differences in CF among fish fed the formulated feeds (P>0.05). Fish fed the feed PM1-2 had a lower HSI, while fish fed the feed FM1 had a higher HSI, than that of fish fed the control feed (P<0.05). There were no significant differences in contents of moisture, protein, lipid and ash in whole body among fish fed the formulated feeds (P>0.05).

Fish fed the raw fish feed had lower feed intake, FCR, NRA and HSI, but higher SGR and final body weight than that of fish fed the control feed (P<0.05). There were no significant differences in CF and whole body components between fish fed the raw fish feed and control feed (P>0.05).

Conclusions:

1. Malabar grouper fed the formulated feed containing 50% fish meal exhibited lower growth performance but higher nitrogen retention efficiency than that of fish fed raw fish feed. There was no significant difference in whole body components between fish fed the control and raw fish feed, but fish fed the control feed exhibited higher HSI than that of fish fed the raw fish feed.
2. Replacing 25 to 75% of the fish meal, by inclusion of poultry product meal, in feed formulation for malabar grouper, or replacing 25 to 50% of the fish meal by inclusion of meat and bone meal, or replacing 25% the fish by inclusion of feather meal, did not significantly negatively affect growth performance, feed utilization and body composition of the fish, although a trend that SGR and final body weight decreased with the decline of fish meal was observed. Replacing 50% of the fish meal with feather meal in feed formulation for malabar grouper reduced growth performance and nitrogen retention efficiency of the fish significantly.
3. We recommended reducing fish meal requirement in feed formulation for malabar grouper from 50% to 37.5% by inclusion of poultry product meal as fish meal substitute. Further research are needed for evaluate protein, energy and amino acid requirement for malabar grouper.
4. Replacing 25 to 50% of the fish meal, by inclusion of a blend of poultry by product meal, meat and bone meal, feather meal and blood meal in feed formulation for malabar grouper did not significantly negatively affect growth performance, feed utilization and body composition of the fish, although a trend that SGR and final body weight decreased with the decline of fish meal was observed. Replacing 75 to 100% of the fish meal with the blend in feed formulation for malabar grouper reduced growth performance, feed conversion ratio and nitrogen retention efficiency of the fish significantly.

5. Adding 1% squid meal did not improve feed intake, growth performance, feed conversion ratio and nitrogen retention efficiency of malabar grouper fed the feeds in which fish meal was substituted by a blend of poultry by product meal, meat and bone meal, feather meal and blood meal.

The ACREC Update
Clemson University Animal Co-Products Research and Education Center (ACREC)
Annel K. Greene, Ph.D., Center Director

All universities are dynamic entities that experience constant change, renewal, and expansion to meet the needs of its constituency. Students enter - students graduate. Faculty members arrive – faculty member's move on to other opportunities or retire. In the last several months, many changes have occurred at Clemson University coinciding with favorable funding support for filling vacant administrative positions.

In the College of Agriculture, Forestry and Life Sciences, Dr. Alan Sams has been hired as Dean. He replaces the Interim Dean, Dr. Calvin Schoulties, who will return to the plant pathology faculty. Dr. Sams most recently served as Head of the Department of Poultry Sciences at Texas A&M University and brings a wealth of animal industries experience and knowledge to Clemson University. We extend our warmest appreciation to Dr. Calvin Schoulties for leading the development of ACREC and for his wisdom and kind assistance in all ACREC endeavors. We are very pleased that Dr. Schoulties will remain actively involved in ACREC.

In the College of Engineering and Science, Dr. Esin Gulari has been hired as Dean. Dr. Gulari served as professor and Chair of the Department of Chemical Engineering and Materials Science at Wayne State University. With her vast experience in chemical engineering and research, Dr. Gulari will be a valuable asset to the university.

In addition, Clemson University has recently hired a new dean of the Libraries, a new dean of students, and is currently searching for a new dean of the College of Business and Behavioral Sciences.

In the university structure, ACREC is a separate department under the leadership of the Center Director with faculty participants from academic departments across two colleges. The Department of Animal & Veterinary Sciences, one of ten university departments currently participating in ACREC, has welcomed a new department chair. Dr. Mary Beck joins Clemson University after nearly 26 years as a professor of animal science at the University of Nebraska-Lincoln. Dr. Beck's career has centered on the study of poultry. Dr. A.B. Bodine, who served as Interim Department Chair, is retiring. However, we are very pleased that Dr. Bodine will be re-hired to work as the undergraduate research coordinator and will continue to work with us in ACREC.

Within ACREC, Dr. Paul Dawson has resigned as Associate Center Director. On behalf of the faculty, staff, and students of the Animal Co-Products Research and Education Center, we extend our appreciation to Dr. Dawson for his service. Dr. Dawson will remain a valued ACREC researcher. This transition has been carefully evaluated among the university administration to determine the best future course for ACREC. Upon reflection that approximately half of the funded ACREC projects

are derived from faculty in the College of Engineering and Science, it is important to have representation on the ACREC Research Committee and Governing Board from that faculty. Therefore, Dr. James G. Goodwin, Jr., Department Chair of the Department of Chemical and Biomolecular Engineering has been asked to serve on the Research Committee and Governing Board. Dr. Goodwin is the preeminent biodiesel catalyst researcher and his wisdom and knowledge will be of great value to the ACREC leadership. In order to assist with the day-by-day duties of the Center, an administrative assistant will be hired for ACREC and, hence, the Associate Center Director position will not be filled at this time. In addition, a group of senior faculty has been selected to serve as advisors to the ACREC Center Director for procedural, policy, and scientific matters.

By their very nature, universities are centers of change. The recent personnel replacements reflect the dynamic nature of a progressive, burgeoning state university and will allow Clemson University and ACREC to continue exploring fresh ideas to meet the challenges of the future.

In other news, ACREC research project proposals will be requested in the near future. If FPRF members have hot topic areas to be considered for inclusion in a Request for Proposals, please e-mail suggestions to Annel K. Greene at agreene@clemson.edu by February 15, 2007.

Biodiesel and Algae (by Sergio Nates)

As I just returned from attending the National Biodiesel meeting in San Antonio, and being familiar with mass production of algae in large-scale aquaculture operations, I found it exciting that according to NBB, the top research need for biodiesel feedstock is the “Development of feedstock on marginal lands (algae).”

Producing biodiesel from algae has been publicized as the most efficient way to make biodiesel fuel. Many studies have demonstrated that algae are capable of producing 30 times more oil per acre than the current crops now utilized for the production of biofuels. According to Michael Briggs, University of New Hampshire, Physics Department**,** research showed that one quad (7.5 billion gallons) of biodiesel could be produced from roughly 500,000 acres of desert land. Similarly, it has been estimated that to replace all transportation fuels in the US, we would require a landmass of almost 15,000 square miles, or roughly 12.5 percent of the area of the Sonora desert. Pictures of large-scale algal culture systems can be viewed at: http://wwwscieng.murdoch.edu.au/centres/algae/BEAM-Net/BEAM-Appl4a.htm

While some species of algae seem to be ideally suited for biodiesel production due to their extremely rapid growth rates, it is important to note that the nutritional value of any algal species depends on its cell size, digestibility, production of toxic compounds, and biochemical composition. Experiments have shown that algae reduce CO_2 emissions by 50% and nitrous oxide by 86%. Since microalgae have much faster growth-rates than terrestrial crops, the per unit area yield of oil from algae (estimated to be between 5,000 to 20,000 gallons per acre, per year), is 7 to 31 times greater than the next best crop, palm oil (635gal).

Some investigations have shown that lipid content and fatty acid composition, key in biodiesel production, can vary considerably according to the culture conditions (Table 1). In addition to nutrition, fatty acid and lipid composition and content are

influenced by a number of other factors. Light enhances the formation of polyunsaturated C_{16} and C_{18} fatty acids as well as mono- and di-galactosyl-diglycerides, sphingolipids and phosphoglycerides. Low temperatures increase the synthesis of polyunsaturated C_{18} fatty acids by some species. Glycerol content is also influenced by culture conditions, particularly NaCl concentrations.

Table 1 Chemical Composition of Algae Expressed on a Dry Matter Basis (%)

Strain	Protein	Carbohydrates	Lipids
Scenedesmus obliquus	50-56	10-17	12-14
Scenedesmus quadricauda	47	-	1.9
Scenedesmus dimorphus	8-18	21-52	16-40
Chlamydomonas rheinhardii	48	17	21
Chlorella vulgaris	51-58	12-17	14-22
Chlorella pyrenoidosa	57	26	2
Spirogyra sp.	6-20	33-64	11-21
Dunaliella bioculata	49	4	8
Dunaliella salina	57	32	6
Euglena gracilis	39-61	14-18	14-20
Prymnesium parvum	28-45	25-33	22-38
Tetraselmis maculata	52	15	3
Porphyridium cruentum	28-39	40-57	9-14
Spirulina platensis	46-63	8-14	4--9
Spirulina maxima	60-71	13-16	6-7
Synechoccus sp.	63	15	11
Anabaena cylindrica	43-56	25-30	4-7

And what about algae meals? Can in the future compete with our products as a fishmeal replacement? The literature on alga meals as feed ingredients is extensive and studies have been conducted with cattle, poultry and aquaculture species. Some few examples include studies with blue-green algae powders. Cyanobacteria have been used as dietary protein sources in Gibel carp and Salmon diets. *Chlorella* and *Tetraselmis* algae biomeals provide the desired omega 3 and omega 6 fatty acids, DHA and EPA, in shrimp aquaculture diets. *Spirulina* meals have been shown to enhance immune function, reproduction and increase growth in chickens. Alga meal supplementation of basal diets in cows resulted in an increase in the firmness of milk fat with concomitant decrease in solid fat content.

In general, results from most studies suggest that meals and oils from heterotrophic microalgal fermentation sources can be potential candidates for fishmeal and marine

oil replacement in animal diets.

Noteworthy Article

Allepuz A, A., Lopez-Quiez, A. Forte, G. Fernandez and J. Casal (2007) Spatial analysis of bovine spongiform encephalopathy in Galicia, Spain. Preventive Veterinary Medicine. *Article In Press.*

In Spain, the first bovine spongiform encephalopathy (BSE) case was detected in 2000 in a cow born in the Galicia region (Northwestern Spain). From then and until October 2005, 590 cases were detected, 223 of them in Galicia. In 1994, meat and bone meal (MBM) was banned on ruminant feed and, in 1996, an EU decision mandating an overall change in MBM processing was implemented. This decision was gradually applied in the territory and not enforced before July 1998. The objective of this study was to explore clustering of BSE cases and estimate the standard incidence ratio (SIR) of BSE in Galicia. This study was based on the BSE cases detected during the surveillance period 2000-2005 in the Galicia region. These cases were divided, based on birth date, into two periods: animals born from 1994 to July 1998, and those born after July 1998. The authors tested the role of cross-contamination on the geographical SIR distribution for both periods. Hierarchical Bayesian models were used to model the over dispersion and lack of independence of the SIR estimates. The geographical distribution of the standard incidence ratio of BSE between both periods was different. In the second period, the SIR was reduced in some areas. The reduction in these areas could be attributable to the changes in the processing of MBM. The authors did not find any statistical link between the poultry population and the standard incidence ratio, but pig population had a positive effect.

"Emerging Issues and Opportunities" Seminar - Spring 2006

An opportunity to meet by video-conference the faculty and staff of the Clemson University Animal Co-Products Research & Education Center. An overview on research progress will be the center of discussion. Attendees will include:

- Dr. Budd Bodine
- Dr. David Bruce
- Dr. Feng Chen
- Dr. John Coates
- Dr. Paul Dawson
- Dr. James G. Goodwin
- Dr. Annel Greene
- Dr. Xiuping Jiang
- Dr. Igor Luzinov
- Dr. A. A. Ogale
- Dr. Thomas R. Scott

Please join us at the Drake Hotel, Chicago, Tuesday. April 24th from 1:00 to 4:00 p.m.

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