52 Albumin, a mammary gland secreting cell keeper. A. Shamay* and Y. Feuermann, *Agricultural Research Organization (ARO), the Volcani Center, Institute of Animal Science*, *Bet Dagan, Israel*.

The extensive lactation performance of the modern cow, due to advance genetic selection is accompanied with advanced apoptotic process. Resent studies in our lab established the ability of leptin to up regulate lactation performance in bovine. Our findings that albumin is synthesizes by the mammary gland and the effect of leptin on the bovine mammary gland, led us to investigate the relationship between leptin, lactation and albumin. Albumin is manufactured in the liver at a rate 9-12 g/d and there is no storage and no reserve. Albumin is catabolized at a rate of 9 - 12 g/d (the same rate as it was produced) by pinoctosis in cells adjacent to the vascular endothelium. Milk whey albumin has the same amino acid sequence as the blood serum molecule. Therefore, increase in milk albumin was taken as evidence for tight junction disruption. Albumin concentration in milk increases during functional transitions from lactation to involution and from involution to lactogenesis and during inflammation. During these periods albumin may augment the immune defenses of the gland. We found that albumin expression was approximately 4 times higher in mastitis mammary gland tissue compared to its expression in healthy tissue. The secretion of albumin was increased 3.5-fold in the mastitic mammary gland tissue explants, relative to the healthy mammary gland tissue explants. We have shown that leptin in the presence of prolactin (simulation of lactation) enhance the expression and accumulation of albumin in the bovine mammary gland. The results of our experiments suggest that the synthesis and secretion of albumin by the mammary gland is part of the innate nonspecific defense system. That albumin synthesis and secretion in the mammary gland is influence by the tissue health status and by hormones and that albumin is a mammary secreting cell keeper.

53 Increased mammary gland oxidative damage and apoptosis during prolonged lactation in the mouse is little affected by overexpression of des(1-3)hIGF-I. D. Hadsell*[1,2], D. Torres[1,2], and J. George[1,2], [1]*USDA/ARS Children's Nutrition Research Center*, *Houston TX*, [2]*Baylor College of Medicine*, *Houston TX*.

Prolonged lactation in the mouse is associated with decreased capacity to produce milk and loss of secretory tissue. This loss of function is delayed in transgenic mice that overexpress des(1-3)hIGF-I (WAP-DES). A primary goal of these studies was to determine the relationship between mammary cell apoptosis and oxidative damage during normal and prolonged lactation. A second goal was to determine if reduced mammary cell apoptosis occurs in WAP-DES mice during prolonged lactation. The percentage of TUNEL-positive mammary cells present in the mammary gland during early and prolonged lactation was analyzed in two separate studies. In study 1, TUNEL staining and mammary protein carbonyl content (CC) was compared in mammary tissue samples collected from lactating mice on days 1, 2, 3, 5, 10, 35, and 57 post partum (4 - 10 animals/day). In study 2 TUNEL analysis was done on mammary tissue samples collected during peak lactation (day 8) or prolonged lactation (day 37) from either nontransgenic or WAP-DES dams (4 -12 dams per time-genotype combination). A third study compared both mammary CC and the content of 8-hydroxy 2'-deoxyguanosine (8-OG) in mitochondrial DNA isolated from glands collected at day 2, 10 and 35 postpartum (3-5 animals/day). In both TUNEL studies, percent apoptosis was lowest at peak lactation (study 1, day 10, 0.2±0.04 %; study 2, day 8, 0.5±0.1%) and increased ($P<0.05$) 2- to 3-fold with prolonged lactation. Apoptosis in mammary tissue from the WAP-DES mice was similar ($P>0.05$) to that of nontransgenic mice. Both markers of oxidative damage change with day postpartum ($p<0.05$). Oxidative damage was high on day 2 decreased on day 10 and then increased on day 35 postpartum (CC, 3.1±0.2, 1.8±0.2, 2.4±0.2 nmole/mg protein respectively; 8-OG, 6.1±0.7, 4.4±0.8, 9.3±.7 nmole/L mitochondrial extract, respectively). These results support the conclusion that apoptosis in association with cellular oxidative damage is increased in the mammary gland during prolonged lactation.

Key Words: Persistence, Apoptosis, Oxidative Stress

54 Endocrine regulation of mammary function and persistency of lactation. T. B. McFadden*, *University of Vermont*, *Burlington*.

Mammary development and lactation are classical examples of physiological processes that are under hormonal regulation. At the level of the mammary gland, milk yield is fundamentally determined by the number of mammary epithelial cells and their secretory activity. In addition, milk production depends on adequate supply of precursor nutrients derived from systemic metabolism and delivered through the mammary blood supply. Each of these factors or processes is regulated by hormones and their overall coordination in support of lactation is likewise under endocrine control. The objective of this paper is to review the endocrine regulation of mammary function and persistency of lactation, with particular emphasis on the effects of pregnancy, nutrition, and environmental factors. For example, changes in the endocrine milieu during pregnancy appear to signal functional changes in the mammary gland that lead to reduction of milk production. Increasing or decreasing the frequency of milking not only alters the amount of milk retained in the udder, with potential effects on endocrine signaling, but also changes the profile of galactopoietic hormones released, especially prolactin and oxytocin. Finally, the imposition of long day photoperiod during lactation elicits increased milk yield through a mechanism that must involve hormonal regulation. In addition to the well known galactopoietic effects of bovine somatotropin, experimental application of other hormones such as oxytocin have been shown to enhance milk yield and persistency of lactation. Further study of these and other hormones, and of their roles in mediating mammary responses to extrinsic factors holds great promise for development of new approaches to enhancing mammary function and lactational persistency.

Key Words: Hormones, Lactation Persistency, Mammary Function

55 Effect of increased milking frequency (4X followed by 2X vs. 3X) in early lactation and its effects on future milk yield. R. Burgos*, L. Odens, L. Baumgard, and M. VanBaale, *University of Arizona*, *Tucson*.

Although frequently recommended and occasionally practiced on dairy farms, the effects of increased milking frequency (IMF) on production parameters are poorly understood. Two-hundred multiparous and 100 primiparous Holstein cows were randomly assigned to one of five milking frequency treatments at parturition to investigate IMF (4X followed by 2X vs. 3X) effects during early lactation and subsequent milk yield persistency. Treatments were 1) 3X milking for 120 DIM; 2) 4X milking from 0 to 10 DIM followed by 2X through 120 DIM; 3) 4X milking from 0 to 20 DIM followed by 2X through 120 DIM 4) 4X milking from 0 to 30 DIM followed by 2X through 120 DIM; and 5) 4X milking from 0 to 40 DIM followed by 2X through 120 DIM. Cows were housed in a dry lot facility under a thermal neutral environment throughout the study. Individual milk yields were collected daily and milk components were obtained monthly. All cows were body condition scored at parturition and every four wks thereafter. Blood was collected from the coccygeal vein at parturition and weekly for 5 wks thereafter using a subset of cows (n=27/trt from control and the cows milked 4X for 40 DIM). Data reported here in were analyzed through 42 DIM. Treatment effected milk yield ($P < 0.05$) between primiparous (31.4^{a}, 25.4^{b}, 27.4^{b}, 29.6^{a}, and 30.8^{a} kg/d) and multiparous (40.7^{a}, 37.1^{bc}, 34.8^{c}, 36.5^{bc}, and 37.9^{b} kg/d) cows milked 4X and 2X compared to 3X, respectively. Data suggest that IMF (4X followed by 2X vs. 3X) immediately post partum does not improve milk yield during the first 6 wks of lactation in primiparous or multiparous cows milked 4X for 10, 20, 30, or 40 DIM compared to 3X milking alone.

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Key Words: Milking Frequency, Early Lactation

56 Peak and persistency: The mathematics of the lactation curve. I. Vetharaniam*[1], S. R. Davis[2], and E. S. Kolver[3], [1]*AgResearch Limited*, *Hamilton, New Zealand*, [2]*ViaLactia Biosciences (NZ) Limited*, *Newmarket, Auckland, NewZealand*, [3]*Dexcel Limited*, *Hamilton, New Zealand*.

Underlying the concept of lactational persistency is a complex of interactions which influence mammary secretory cell number and activity over the course of the lactation. The secretory cell population in the bovine mammary gland consists of alveoli in both active (secreting) and quiescent (engorged) states. We hypothesize that prolonged engorgement is a key regulator of changes in gene expression that lead to de-differentiation and secretory cell death. The number of active alveoli, modulated post partum primarily by nutrition and milking frequency, governs the capacity for milk production. Quiescent alveoli provide a latent secretory potential which can be unlocked through disgorgement of milk. Early in lactation, proliferation of progenitor cells provides new alveoli, resulting in growth of the mammary gland. After peak lactation, the size of the quiescent pool and the rate of cell death, driven from that pool, govern the rate of regression of the gland, and thus the persistency of the lactation. These biological dynamics have recently been incorporated into mathematical models which predict the active and quiescent secretory cell pools through time. This has allowed mechanistic description as to how milking frequency and nutrition might interact with persistency. In particular, chronic effects of nutrition are proposed to regulate the induction phase of apoptosis, while the influence of milking frequency is at the initiation of quiescence (and the size of the quiescent pool of secretory cells). This paper presents these models and discusses their results and their biological implications. Key experiments are identified which could be performed to either strengthen or refute key assumptions in the model. The sensitivity of the lactation curve to up- and down-regulation of pathways in the mammary gland are examined in considering strategies for improving production and its persistency. Differences between New Zealand and North American Holsteins in the way that nutrition modulates udder regression through apoptosis of mammary cells are considered in light of modelling predictions.

Key Words: Mathematical Modelling, Milking Frequency, Nutrition

Nonruminant Nutrition: Dietary Supplements and Additives

57 Growth performance and intestinal morphology responses to diet supplementation with spray-dried plasma protein and organic complex copper in weanling pigs housed under sanitary and sub-sanitary conditions. A. Harper*, J. Zhao, M. Estienne, K. Webb, Jr., and A. McElroy, *Virginia Polytechnic Institute and State University*, *Blacksburg*.

Weanling pigs (n = 192, 18 ± 2 d of age, 6.0 ± 0.2 kg BW) were used to investigate effects of dietary addition of spray-dried plasma protein (SDPP, 0 or 6% for 10 d) and copper from an organic copper complex (0 or 200 ppm for 35 d) on growth performance and intestinal morphology under sanitary or sub-sanitary conditions. The sub-sanitary condition was created by applying swine manure slurry to all surfaces of the sub-sanitary pens during the wk prior to weaning with the understanding that pen sanitation and nursery room would be confounded. There were four pigs per pen; feed and water were available ad libitum. On d 10, one pig per pen was killed and sections of duodenum, jejunum and ileum were fixed, stained and prepared for microscopic assessment of mucosal morphology. By d 10 post-weaning, SDPP and copper supplementation improved ADG and ADFI ($P < 0.001$), while pigs reared in the sub-sanitary pens had lower ADG ($P < 0.05$) than those from sanitary pens. Trends for interaction of diet and pen sanitation were observed for G:F with more pronounced response to SDPP ($P < 0.07$) or copper ($P < 0.11$) supplementation in the sub-sanitary pens. By d 35, there were no main or interactive effects of treatment on performance ($P = 0.19$). In each intestinal segment, shorter villus length and less crypt depth were observed in pigs housed in the sub-sanitary pens ($P < 0.05$). In the duodenum, reduced crypt depth with copper supplementation ($P < 0.01$) and a trend for greater villus length with SDPP supplementation ($P < 0.09$) were observed. Under these experimental conditions, SDPP and copper supplementation improved pig growth performance during the initial 10 d post-weaning and responses for G:F tended to be greater under sub-sanitary conditions. Poor sanitation conditions in the pig housing environment appear to have a negative impact on mucosal morphology.

Key Words: Pigs, Spray-Dried Plasma, Copper

58 Dietary spray-dried plasma and lactating sow feed intake. J. Crenshaw*[1], J. Mencke[2], R. Boyd[2], J. Campbell[1], B. Allen[1], and L. Russell[1], [1]*APC Incorporated*, *Ankeny, IA*, [2]*The Hanor Company*, *Franklin, KY*.

Segregated-parity PIC sows (n = 894) were fed lactation feed with 0% or 0.5% dietary spray-dried plasma (SDP) to determine the effects of SDP on sow feed intake, wean to estrus interval, and pig survival to weaning. There were 112 first parity sows, 112 second parity sows, and 223 older parity (> 2) sows per treatment in experiment 1. In a second experiment, 2,116 older PIC sows (parity, > 2) were fed lactation feed with 0% or 0.5% SDP to evaluate the effects of SDP on sow feed intake, pig survival to weaning and weaning weight of pigs. Litter weaning weight data were collected on 588 litters. At weaning (average 16 d of age), pigs were weighed and pig quality was recorded (high quality pigs weighed 3.6 or more kilograms at weaning). In both experiments, feed intake data were collected from individual sow feed records with feed additions to feeders recorded daily. Feed data were subjected to repeated measures analysis. In experiment 1, SDP increased feed intake of first parity sows (+0.82 kg/d; $P < 0.001$) and second parity sows (+0.23 kg/d; $P = 0.117$), but reduced feed intake of older parity sows (-0.20 kg/d; $P = 0.023$). First parity sows fed SDP had fewer days (-2.5) to postweaning estrus ($P = 0.001$). Older sows fed spray-dried plasma had improved ($P = 0.025$) pig survival (92.0% vs. 89.3%). In the second experiment, SDP reduced ($P < 0.001$) feed intake (-0.34 kg/d) of older parity sows and had no effect ($P > 0.25$) on pig survival to weaning, but the number of high quality pigs (> 3.6 kg) weaned was increased 0.35 pigs per litter from sows fed SDP ($P = 0.017$). Also pigs from sows fed SDP were 0.25 kg heavier ($P = 0.001$) at weaning than pigs from control sows. In conclusion, SDP increased feed intake in younger sows and reduced days to estrus in first parity sows. Although SDP reduced feed intake in older sows, both heavier pigs at weaning and increased number of high quality pigs at weaning from sows fed spray-dried plasma suggest that metabolic efficiency of the lactating sow was enhanced and milk production was improved.

Key Words: Swine, Lactation, Spray-Dried Plasma

59 Effects of Bio-Mos® and carbadox on gastrointestinal pH, organ weight and morphology of nursery pigs. J. Miguel* and J. Pettigrew, *University of Illinois*, *Urbana*.

A 3-wk experiment was conducted to evaluate the effect of a mannan oligosaccharide product (Bio-Mos®) and antibiotic (carbadox) on gastrointestinal characteristics of pigs. Thirty pigs were weaned at an average of 21.2 d and 5.95 kg BW. At weaning, six pigs were euthanized for gastrointestinal sample collection, while the remaining 24 pigs were randomly allocated to one of four dietary treatments. The experiment was conducted as a 2 x 2 factorial arrangement, with the factors being 0 or 0.2% Bio-Mos® and 0 or 55 ppm carbadox. Twelve pigs, representing three pigs per treatment, were euthanized on each of 2 days, 7 or 21 d post-wean. Gastrointestinal pH and wet empty organ weight measurements were taken as well as tissue samples from the duodenum, jejunum and ileum for morphological measurements. For the entire group of 30 pigs, the wet empty weight of the stomach, small intestine and large intestine (including cecum) as a percentage of body weight, was significantly smaller ($P < 0.001$) for pigs at weaning compared to older pigs. For intestinal morphology, pigs at 7