738 Jersey × Holstein crossbred cows compared to pure Holstein cows for fertility and survival during the first three lactations. B. J. Heins*, L. B. Hansen, A. R. Hazel, A. J. Seykora, D. G. Johnson, and J. G. Linn, *University of Minnesota*, *Saint Paul*.

Jersey × Holstein crossbred (**J×H**, n = 80) cows were compared to pure Holstein (n = 77) cows for days to first breeding, number of inseminations, days open, pregnancy rate, survival to second lactation, and survival to third lactation during the first three lactations. Cows were in two research herds of the University of Minnesota and calved from September 2003 to June 2008. The J×H cows were mated to Montbeliarde sires, and Holstein cows were mated to Holstein sires. For days open, cows were required to be at least 250 d in milk and those with greater than 250 d for days open were truncated to 250 d. Independent variables for statistical analysis of days to first breeding, number of inseminations, and days open were the fixed effects of herd, season (fall or spring) nested within herd, breed group, lactation number nested within breed group, and cow within breed group was a random effect. For pregnancy rate, survival analysis was used to assess breed differences. For survival, a Chi-square test was used to evaluate breed differences. The JxH cows had significantly ($P < 0.05$) fewer days to first breeding in first (79 d vs. 90 d), second (78 d vs. 86 d), and third (64 d vs. 77 d) lactation. Additionally, JxH cows were not significantly different from pure Holstein cows for number of inseminations in first and third lactations. However, in second lactation, J×H cows had significantly ($P < 0.05$) fewer number of inseminations (2.21 vs. 2.73) than pure Holstein cows. For days open, J×H cows had significantly ($P < 0.05$) fewer days open than pure Holstein cows in first lactation (124 d vs. 148 d), second lactation (121 d vs. 163 d), and third lactation (158 d vs. 200 d). Furthermore, J×H cows had significantly ($P < 0.05$) higher pregnancy rates in first (20% vs. 12%) and second (25% vs. 13%) lactations. For survival to second calving, J×H cows (80%) were not significantly different from pure Holstein cows (71%). However, more JxH cows (64%) tended ($P < 0.10$) to calve a third time than pure Holstein cows.

Key Words: crossbreeding, heterosis, Jersey

739 Jersey × Holstein crossbred cows compared to pure Holstein cows for production, SCS, and udder measurements during the first three lactations. B. J. Heins*, L. B. Hansen, A. R. Hazel, A. J. Seykora, D. G. Johnson, and J. G. Linn, *University of Minnesota*, *Saint Paul*.

Jersey × Holstein crossbred (J×H, n = 76) cows were compared to pure Holstein (n = 73) cows for 305-d milk, fat, and protein production, lifetime production, SCS, and udder measurements during the first three lactations. Cows were in two research herds of the University of Minnesota and calved from September 2003 to June 2008. The J×H were mated to Montbeliarde sires, and Holstein cows were mated to Holstein sires. Best Prediction was used to determine lifetime production (to 1220 d after first calving) and actual production for 305-d lactations with adjustment for age at calving, and records less than 305 d were projected to 305 d. Independent variables for statistical analysis were the fixed effects of herd, season (fall or spring) nested within herd, breed group, lactation number nested within breed group, and cow within breed group, which was a random effect. During first lactation, JxH (518 kg) and pure Holstein (526 kg) cows were not significantly different for fat plus protein production. However, during second (605 kg vs. 630 kg) and third (609 kg vs. 660 kg) lactations, JxH cows were significantly ($P < 0.05$) lower for fat plus protein production than pure Holstein cows. The JxH cows were not significantly different from pure Holstein cows for SCS during first and second lactations; however, JxH cows (3.80) tended ($P < 0.10$) to have higher SCS than pure Holstein cows (3.40) during third lactation. The J×H cows were not significantly different from pure Holsteins for lifetime milk (19,194 kg vs. 21,448 kg) and lifetime fat plus protein (1,361 kg vs. 1,455 kg) production. For udder measurements, JxH cows had significantly ($P < 0.01$) less udder clearance from the ground than pure Holstein cows in first (47.8 cm vs. 54.8 cm), second (42.4 cm vs. 51.4 cm), and third (40.4 cm vs. 48.9 cm) lactations. Furthermore, JxH cows had significantly ($P < 0.01$) greater distance between front teats in first (15.7 cm vs. 14.0 cm), second (17.0 cm vs. 14.7 cm), and third (17.7 cm vs. 15.6 cm) lactation than pure Holstein cows.

Key Words: crossbreeding, heterosis, Jersey

740 Positive percent heterosis for fat-corrected milk per day of life from Holstein-Jersey diallel. R. D. Shanks*[1], B. G. Cassell[2], K. M. Olson[2], A. J. McAllister[3], and S. P. Washburn[4], [1]*University of Illinois*, *Urbana*, [2]*Virginia Polytechnic Institute and State University*, *Blacksburg*, [3]*University of Kentucky*, *Lexington*, [4]*North Carolina State University*, *Raleigh*.

Objective was to estimate heterosis for performance of a population of dairy cows from a diallel crossbreeding experiment [S-1040 regional research project]. Fat-corrected milk was proposed almost a century ago to evaluate breeds on an energy basis. Milk per day of life can evaluate efficiency by combining the effects of lifetime milk production and length of life. Integrating the two concepts identified fat-corrected milk per day of life (FCMPD) as the variable of choice for the estimation of heterosis. Residuals for FCMPD were more normally distributed than were residuals for lifetime milk production or length of life. The 230 cows for this analysis were born between June 2003 and September 2006, housed in North Carolina (NC)(34), Kentucky (KY)(49) and Virginia (VA)(147), and were required to have initiated at least one lactation. Most cows were alive in January 2009, NC (31), KY (45) and VA (98). Holsteins (H) and Jerseys (J) defined the four breed groups, with sire breed first, of 66 HH, 55 HJ, 65 JH, and 44 JJ cows. The general linear model for analysis included effects of herd (KY, NC, or VA), alive status (alive or dead), birth year (2003, 2004, 2005, or 2006) and breed group (HH, HJ, JH, or JJ). The model accounted for 71% of the variation in FCMPD and all factors were significant. The KY herd had the greatest FCMPD and the NC herd had the smallest FCMPD. Older cows had longer opportunities for performance and had higher FCMPD. Least squares means (standard errors) for FCMPD ranged from 14.0 kg (.6) for cows born in 2003 to 3.2 kg (.5) for cows born in 2006. Cows still alive had higher FCMPD than dead cows. Percent heterosis for FCMPD was estimated as 16.8%. Least squares means (standard errors) for FCMPD for the breed groups were 10.18 kg (.41) for HJ, 10.34 kg (.42) for JH, 9.84 kg (.39) for HH, and 7.72 kg (.43) for JJ indicating overdominance of the crossbreds. Actual FCMPD is expected to rise as more cows complete their lifetimes and the percent of active cows is reduced.

Key Words: fat-corrected milk per day of life, heterosis, crossbreeding

741 Energy balance in first lactation Holsteins, Jerseys, and reciprocal crosses estimated using random regression. K. M. Olson*, B. G. Cassell, and M. D. Hanigan, *Virginia Polytechnic Institute and State University*, *Blacksburg*.

The Virginia Tech crossbreeding project mated Holstein and Jersey females to four Holstein and four Jersey bulls to create HH, HJ, JH, and JJ breed groups (sire breed listed first). Intakes were measured from September 2005 to March 2008 for two weeks out of every six week period on cows in first lactation and less than 306 days in milk. Cows with intake observations numbered 44, 32, 29, and 13 for HH, HJ, JH, and JJ, respectively. NEL (Mcal) was calculated from ration analyses. Body and milk weights were collected daily with milk components measured monthly. NEL requirements for maintenance, growth, production, and pregnancy were calculated using NRC (2001) equations. Random regression models were used to estimate NEL of consumption and NEL required for production, maintenance, and body weight at every week in lactation (WOL). Energy required for growth was calculated for each cow at each stage of lactation (five two month stages). Energy balance was estimated at every WOL by subtracting energy required for production, maintenance, growth, and pregnancy from NEL consumed. A linear model with fixed effects of breed group, year-season of freshening group, and a linear and quadratic effect of age at calving was used to analyze energy terms. HJ and JH were not different in any analyses for energy terms. The HH cows consumed more energy than HJ and JJ. There were no breed group differences for total energy required for pregnancy. The HH, HJ, and JH were not different for energy required for production but were different from JJ. No differences were found for percent energy used for pregnancy and growth. The JH allocated less energy to maintenance than the HH (25.8% versus 27.6%). There were no breed group differences for week of return to positive energy balance or positive cumulative energy balance. Breed group explained significant variation for cumulative energy balance at the end of lactation ($P < 0.10$), but no pair of breed groups differed significantly.

Key Words: crossbreeding, dairy cows, energy balance

742 Calving traits, gestation length, and birth weight of Montbeliarde sires mated to Holstein or Jersey × Holstein crossbreds. B. J. Heins, L. B. Hansen*, A. R. Hazel, A. J. Seykora, D. G. Johnson, and J. G. Linn, *University of Minnesota*, *Saint Paul*.

Pure Holstein cows (HOL) and Jersey × Holstein crossbred cows (J×H) were compared for calving difficulty (CD), stillbirths (SB), gestation length (GL), calf birth weight (BW), and twinning rate (TR). Cows were in two research herds of the University of Minnesota and calved from August 2003 to December 2008. HOL (n=415) bred to either Holstein or Montbeliarde AI bulls during second and later lactation were compared to determine the effect of breed of sire. Statistical models for analysis of CD, SB, GL, and BW included the fixed effects of herd, sex of calf, breed group, and cow, which was a random effect. For CD and SB, respectively, calves (n=138) sired by Montbeliarde bulls (9.3%, 4.3%) were not significantly different from calves (n=277) sired by Holstein bulls (5.9%, 4.1%). The Montbeliarde-sired calves (283.2 d) also had significantly ($P < 0.01$) longer GL than Holstein-sired calves (278.4 d). Montbeliarde-sired calves (n=134) had significantly ($P < 0.01$) higher BW (48.3 kg vs. 43.3 kg) compared to Holstein-sired calves (n=266). Additionally, HOL mated to Holstein sires and J×H mated to Montbeliarde sires were compared during their first three lactations. Statistical models for analysis of CD, SB, GL, and BW included fixed effects of herd, season (fall or spring) nested within herd, sex of calf, breed group, lactation number nested within breed group, and cow within breed group, which was a random effect. However, a Chi-square test was needed to evaluate breed differences for TR. For CD and SB, JxH (n=177) were not significantly different from HOL (n=160) during the first three lactations. GL was significantly ($P < 0.05$) longer for J×H than HOL in first (280.3 d vs. 277.7 d), second (280.7 d vs. 278.4 d), and third (283.8 d vs. 278.8 d) lactation. Across lactations, JxH had a significantly higher ($P < 0.05$) TR than HOL (7.7% vs. 3.0%). J×H tended ($P < 0.10$) to have Montbeliarde-sired calves (n=71) with less BW (37.6 kg vs. 38.9 kg) than pure Holstein calves (n=74) during first lactation.

Key Words: calving difficulty, crossbreeding, stillbirths

743 Montbeliarde-sired crossbred cows compared to pure Holstein cows for body weight, body condition score, hip height, dry matter intake, and production during the first 150 days of first lactation. A. R. Hazel*, B. J. Heins, L. B. Hansen, A. J. Seykora, D. G. Johnson, and J. G. Linn, *University of Minnesota*, *Saint Paul*.

Differences in body weight (BW), body condition score (BCS), hip height (HH), dry matter intake (DMI), and milk, fat, and protein production were compared for Montbeliarde-sired crossbred cows (MX, n = 57) and pure Holstein cows (HOL, n = 40). MX consisted of 33 F_1 crossbreds of Montbeliarde x Holstein (MH) and 24 3-breed crossbreds of Montbeliarde x Jersey/Holstein (MJH). Data was collected during the 147-d interval from 4 d to 150 d postpartum of first lactation. Cows were housed at the University of Minnesota research facility, St. Paul, and calved during fall seasons between October 2005 to December 2007. BW and BCS were recorded bi-weekly, and HH was measured once between 20 and 172 DIM. Cows were individually fed a TMR twice daily, and feed weighbacks were collected once daily during a 147-d interval from 4 d to 150 d postpartum. Independent variables for the statistical analysis of BW, BCS, HH, DMI, and production were age at calving (mo, linear), year of fall calving, breed of sire (Holstein vs. Montbeliarde), and MH vs. MJH nested within breed group for all dependent variables. Furthermore, period postpartum (14-d for BW and BCS and 7-d for DMI) within breed of sire (Holstein vs. Montbeliarde), and random effect of cow nested within breed of sire and MH vs. MJH were added to the model for BW, BCS, and DMI. MX had significantly ($P < 0.01$) more BW than HOL (537 kg vs. 514 kg, respectively), and MH (550 kg) had more BW ($P < 0.01$) compared to MJH (524 kg). For BCS, MX had more BCS ($P < 0.01$) than HOL (3.28 vs. 2.72). However, MX (139 cm) had significantly ($P < 0.01$) shorter HH than HOL (141 cm). DMI did not differ for MX and HOL (19.3 kg vs. 20.0 kg, respectively). Fat plus protein production during the interval from 4 d to 150 d postpartum did not differ for MX and HOL (305 kg vs. 308 kg), nor did MH (303 kg) differ from MJH (308 kg). In summary, DMI and production did not differ between MX and HOL, but MX maintained more BCS and BW in early lactation than HOL.

Key Words: crossbreeding, Montbeliarde, dry matter intake

744 A comparative study of Holstein and Jersey crossbred cows in 14 Australian dairy herds. M. F. Pyman*, G. A. Anderson, and K. L. Macmillan, *University of Melbourne*, *Werribee, Victoria, Australia*.

Production, reproduction and somatic cell count (SCC) data were analysed in a study of Australian seasonally calving, pasture-based dairy herds with at least 15% crossbred cows of first cross Jersey × Holstein (JJFF) and backcross Holstein x Jersey Holstein (FFJF) breed type. Proc GLIMMIX of SAS was used for analysis. Production and reproduction data from 669 JJFF and 305 FFJF cows in 14 herds were analysed to produce least squares means adjusted for herd, age group and calving to the start of mating. Over 305 days the backcross FFJF cows produced a similar amount of fat (4.9 ± 3.8 kg difference, p=0.20) but significantly more litres (515 ± 100L difference, p<0.0001), protein (10.5 ± 3.3 kg, p=0.0014) and fat plus protein (15.4± 6.9 kg, p=0.026) than the JJFF cows. The JJFF first cross cows had superior reproductive performance compared to the FFJF backcross cows for conception rate to first service (n=615, 57.6% versus 48.2%, n=279, p=0.012) and pregnancy rate after 42 days of breeding (67.6% versus 60.5%, p=0.039) but similar performance in pregnancy rate after 14 weeks of breeding (84.3% versus 82.6%, p=0.48) and not pregnant at the end of breeding (13.7% versus 13.9%, p=0.93). Ln(lactation mean SCC) from 13 herds was analysed in a linear model to produce geometric means of SCC after adjusting for herd and age group. The 199 FFJF backcross cows had a geometric mean significantly lower than the 501 first cross JJFF cows (50.8′000 cells/ml versus 60.1′000 cells/ml, p=0.035). Results indicate that expression of hybrid vigour was variable in the FFJF backcross as it achieved a similar reproductive performance to the first cross JJFF after 14 weeks of breeding and at the end of the breeding period while attaining superior production and a lower geometric mean SCC for the lactation. The backcross FFJF cow would appear to be a viable breed type for pasture-based, seasonally calving dairy herds.

Key Words: seasonal calving, first cross, backcross

745 Preliminary analysis of NRF-Holstein crossbred cattle in Israel. E. Ezra[1], Y. Zeron[2], and J. I. Weller*[3], [1]*Israel Cattle Breeders Association, Caesaria, Israel*, [2]*Sion, Shikmim, Israel*, [3]*ARO, The Volcani Center, Bet Dagan, Israel*.

Approximately 99% of all dairy cows in Israel are Holsteins. Over the last decade samples of Holstein cows have been inseminated with imported semen from several different breeds, including Montbeliard and Jersey. Importation of Norwegian Red (NRF) semen began in 2005. This is the first report on the performance of F1 NRF-Holstein crosses in Israel. The analysis was based on 27 herds with at least 4 crossbred cows with at least 75 DIM per herd-year-season. Cows were included only if their sires had reliability > 0.75 for production traits. Two seasons were defined within each herd-year beginning in April and October. The analysis was based on 1425 purebred and 168 crossbred first parity cows, daughters of 108 Holstein and 3 NRF sires. Mean DIM were 231 and 246, respectively. There were two bases for comparison: the mean phenotypic values of first parity purebred and crossbreed cattle in these herds, and the mean breeding values of the sires of these cows, weighted by the number of daughters per bull. Breeding values for milk, fat and protein production were computed by the multitrait animal model, with parities 1 through 5 as correlated traits. Only purebred Holsteins had records for later parities. Results of the two comparisons are presented in Table 1. Differences were very similar for both criteria for all five traits, even though the purebred breeding values were based on multiple parities. Direct effects of sire breed on dystocia and calf mortality were compared based on 6009 purebred and 2112 crossbred calvings in these herds. Purebred Holsteins were 0.45% lower for mean dystocia, and 0.08% higher for calf mortality. Differences in the mean weighted breeding values were the same for dystocia. Mean breeding values for calf mortality were 0.25% higher for purebreds.

Table 1. Comparison of the purebred and crossbred cows for milk production traits

Comparison	Cow type	Milk (kgs)	Fat (kgs)	Protein (kgs)	Fat %	Protein %
Phenotypic	purebred	12,122	428.5	384.5	3.55	3.18
	crossbred	11,500	406.9	373.9	3.55	3.26
	difference	622	21.6	10.6	0.00	-0.08
Breeding values	purebred	97	9.7	8.1	0.06	0.05
	crossbred	-555	-14.3	-5.2	0.05	0.12
	difference	653	23.9	13.3	0.01	-0.07

Key Words: crossbreeding, Israeli Holsteins, NRF

746 Brown Swiss × Holstein crossbreds compared to pure Holsteins for production, SCS, milking speed, days to first breeding and days open. S. Bloettner*[1], M. Wensch-Dorendorf[1], H. H. Swalve[1], B. J. Heins[2], and L. B. Hansen[2], [1]*Group Animal Breeding, Halle (Saale), Saxony-Anhalt, Germany*, [2]*Department of Animal Breeding, University of Minnesota, Saint Paul*.

The objective of the study was to assess the competitiveness of Brown Swiss x Holstein crossbreds (BSH) with respect to dairy production traits. BSH (n = 55) were compared to pure Holsteins (HOL, n = 50) during the first three lactations for 305-d milk, fat and protein production, SCS, days to first breeding and days open at the experimental station in Iden, Germany. First calvings started in September 2005. All animals originated from a designed experiment. Best Prediction was used to determine actual production for milk, fat, protein and SCS. Data was pre-adjusted for age at calving and records less than 305 d were extended to 305 d. Variables in the model for statistical analysis of production and fertility were the fixed effects of breed group, lactation number, lactation number nested within breed group, season of calving (fall or spring) nested within lactation number, and cow within breed group was a random effect in the model. For 305-d milk production, BSH and HOL were not significantly different in first (8,689 kg. vs. 8,889 kg.) or second (10,251 kg. vs. 10,446 kg.) lactation. During third lactation, BSH (10,450 kg) were significantly ($P < 0.05$) lower than pure HOL (11,096 kg) for milk volume. BSH and HOL were not significantly different for fat plus protein production in first (668 kg vs. 674 kg), second (786 kg vs. 801 kg) and third lactation (812 kg vs. 794kg). Across lactations, BSH and HOL were not significantly different for SCS (2.72 vs. 2.68). BSH had significantly ($P < 0.01$) lower average milk flow (kg/min) than HOL (1.91 vs. 2.19, respectively) across the three lactations. Average milking time was significantly ($P < 0.01$) greater for BSH (5.68 min) than for HOL (5.05 min). Over all lactations, BSH had significantly ($P < 0.01$) fewer days to first breeding than HOL (78 d vs. 84 d, respectively). For days open, BSH and HOL did not differ significantly during first (94 d vs. 107 d), second (102 d vs. 116 d) and third (119 d vs. 121 d) lactation. Summarizing, BSH were equal in production and had lower cell counts in first lactation than HOL.

Key Words: crossbreeding, Brown Swiss, production

747 Brown Swiss × Holstein crossbreds compared to pure Holsteins for body weight, back fat thickness and udder measurements during the first two lactations. S. Bloettner*[1], M. Wensch-Dorendorf[1], H. H. Swalve[1], J. Guehne[2], B. J. Heins[3], and L. B. Hansen[3], [1]*Group Animal*

Breeding, Halle (Saale), Saxony-Anhalt, Germany, [2]*Technical College for Agriculture, Haldensleben, Saxony-Anhalt, Germany*, [3]*Department of Animal Science, University of Minnesota, Saint Paul*.

The objective of the study was to assess the competitiveness of Brown Swiss x Holstein crossbreds (BSH) with respect to body weight and body measurements. BSH (n = 55) were compared to pure Holsteins (HOL, n = 50) for body weight (BW), backfat thickness (BF), udder clearance, teat length, and teat placement during first and second lactation. BF was measured with ultrasonography between the hooks and the thurl. Udder clearance was measured from the floor to the bottom of the udder. All animals originated from a designed experiment. Variables in the model for statistical analysis were the fixed effects of breed group, lactation number, lactation number nested within breed group, season (fall and spring) nested within lactation number, and days in milk nested within lactation number. Cow within breed group was a random effect in the model. Across lactations, BSH had significantly ($P < 0.05$) more BW than HOL (669 kg vs. 648 kg). During first (620 kg vs. 594 kg) and second (678 kg vs. 656 kg) lactations, BSH had significantly ($P < 0.05$) more BW than HOL. For BF, BSH (17.7 mm) tended ($P < 0.10$) to have more BF than HOL (16.3 mm) across the two lactations. However, BSH had significantly ($P < 0.01$) more BF (18.2 mm vs. 15.8 mm) than HOL in first lactation. HOL had significantly more udder clearance ($P > 0.01$) than BSH in first (60.0 cm vs.62.4 cm) and second lactation (52.3 cm vs. 56.9 cm). Rear udder clearance was significantly less ($P > 0.01$) for BSH than HOL in first (59.9 cm vs. 62.7 cm) and second lactations (52.0 cm vs. 57.1 cm), respectively. Teat length was significantly ($P < 0.05$) longer for BSH in first lactation (5.10 cm, front; 4.29 cm, rear) than for pure HOL (4.81 cm, front; 3.96 cm, rear). During second lactation, BSH had significantly ($P < 0.05$) longer front teats (5.0cm vs. 4.6 cm) and rear teats (4.0 cm vs. 3.6 cm) than HOL. Across first and second lactation, BSH (2.21 cm) had ($P < 0.05$) wider rear teats than HOL (2.11 cm). Summarizing, BSH had more body weight across lactation and differed in various body measurements from HOL.

Key Words: crossbreeding, Brown Swiss, heterosis

Dairy Foods: Dairy Foods Processing/Enzymes

748 Whey—From gutter to gold. P. J. Jelen*, *University of Alberta, Edmonton, AB, Canada*.

Whey.. oh whey! Where are the days when whey was a bothersome liquid resulting from the manufacture of cheese or casein and when pigs loved it! Careers were built on research projects aimed at utilization of this golden-green fluid, and descriptions of its magic properties were recorded in the literature since the days of Hippocrates. When nutrition became king, products based on whey started appearing on the market with increased frequency. Use of whey by modern dairy and food industries has developed along four main avenues: 1-products based on whole whey (principally whey cheeses and drinks); 2-products based on whey protein; 3-traditional and novel uses of lactose; and 4- everything else the whey research community came up with. Historically, the first attempts to utilize whey were aimed at "cutting the losses" of the cheesemakers by finding the least expensive disposal route, including uses as spraying onto pastures, transforming whey into animal feed, or simply discharging it into nearby streams. Crystallizing lactose from whey added some value, but brought the problem of what to do with the lactose. Nowadays, lactose is being crystallized mainly from the ultrafiltration permeates which replaced whey as the bad boy of the dairy industry, while whey itself is becoming the main product of interest in cheesemaking. Development of the various whey protein-based products advanced along two parallel and sometimes intertwined lines, technological and/or physiological functionality, and brought about the needed valorization aspect of whey usage for the mainstream processors. Whey drinks and whey cheeses, the traditional routes for turning whey into profitable products, are still important mainly in local markets as shown by the continued success of the Swiss whey drink, Rivella, or the popularity of the various whey cheeses in many countries. Some of the more unusual avenues for whey valorization, some of which are still in the "pipedream stage" include direct or indirect conversion into methane, economical production of unique high value lactose-based ingredients (e.g. "humanized oligosaccharides") or profitable utilization of the main whey ingredient, the cow-water.

Key Words: whey, history, products

749 Protein-interactions in heat-treated milk and effect on rennet coagulation. P. Kethireddipalli*, D. G. Dalgleish, and A. R. Hill, *University of Guelph, Guelph, ON, Canada*.

The underlying molecular processes that cause impaired rennet clotting of heat-treated bovine milk were investigated. Firstly, the effect of whey protein(WP)/κ-casein complexes bound to the casein micelle on the elastic modulus (G′) and gelation times (T) of renneted heat-treated milk was examined. Milks with different levels of micelle-bound WP (<5% to ~80%) were produced by heating skim milk at 90°C for 10 min at pH values ranging from 6.3 to 7.1. WP was quantified using SDS-PAGE. Lower pH produced higher micellar WP association and vice versa. Using oscillatory rheometry, we found that compared to unheated milk (G′, 83.5 Pa; T, 10 min) all heat-treated milks, after renneting, showed a remarkable reduction in G′ (0.1 to 2.1 Pa) and a large increase in T (55 to 130 min). It did not seem to matter if the WP/κ-casein complexes were predominantly bound to the casein micelle (pH 6.3) or were largely present as soluble protein complexes in the lactoserum (pH 7.1). In the second part, the individual effects of casein micelles and lactoserum on the rennet gelation properties of heated milk were investigated. Two different milk systems were examined; one was prepared by re-suspending casein micelles from milk heated at pH values 6.3, 6.7, or 7.1 in native serum from unheated milk, and the other contained native micelles from unheated milk in the serum from the various pH- and heat-treated milks. Heat- and pH-modified casein micelles suspended in native serum significantly lowered the G′values of the resulting rennet gels. With the exception of pH 6.3, the heated lactoserum also interfered with gelation of heat-treated milks. In the final part of our study, the serum from heat-treated milks was further examined after its ultrafiltration (removes WP/κ-casein complexes) or its dialysis against unheated milk (restores ionic composition). Both these processes significantly improved serum performance. This clearly demonstrated that not only serum ionic factors, but also serum WP/κ-casein complexes, and heat-modified casein micelles (with or without associated WP) significantly interfere with the rennet gelation of heat-treated milks.

Key Words: heat-treated milk, rennet, WP/κ complexes