International Journal of Sport Nutrition and Exercise Metabolism, 2002, **12,** 461-469
© 2002 Human Kinetics Publishers, Inc.

The Effect of Bovine Colostrum Supplementation on Exercise Performance in Elite Field Hockey Players

Zandrie Hofman, Rolf Smeets, George Verlaan, Richard v.d. Lugt, and Peter A. Verstappen

In a double-blind, randomized, placebo-controlled study, we investigated the effect of 8 weeks of supplementation with bovine colostrum (Intact™) on body composition and exercise performance (5 × 10-m sprint, vertical jump, shuttle-run test, and suicide test). Seventeen female and 18 male elite field hockey players, including players from the Dutch national team, received either 60 g of colostrum or whey protein daily. The 5 × 10-m sprint test performance improved significantly (p = .023) more in the colostrum group [0.64 ± 0.09 s (mean ± *SEM*)] compared to the whey group (0.33 ± 0.09 s). The vertical jump performance improved more in the colostrum group (2.1 ± 0.73 cm) compared to the whey group (0.32 ± 0.82 cm). However, this was not statistically significant (p = .119). There were also no significant differences in changes in body composition and endurance tests between the 2 groups. It is concluded that in elite field hockey players, colostrum supplementation improves sprint performance better than whey. However, there were no differences with regard to body composition or endurance performance.

Key Words: ergogenic aids, bioactive components, endurance exercise, high muscle power output exercise, Intact, whey protein

Introduction

Bovine colostrum is secreted by cows during the first days after calving and is a rich source of protein, carbohydrates, vitamins, minerals, and bioactive components like growth factors, immunoglobulins, and anti-microbial proteins. The concentrations of these bioactive components are higher in colostrum than in normal milk (2, 8, 9, 11–13).

There have been recent human studies in which the effect of colostrum supplementation on exercise performance were examined. The first study by Mero et al.

Z. Hofman, R. Smeets, and G. Verlaan are with Numico Research, Bosrandweg 20, 6704 PH, Wageningen, The Netherlands. R.v.d. Lugt and P.A. Verstappen are with the Sports Medical Centre, Sweelinckplein 46, 2517 GP, Den Haag, The Netherlands.

(10) in which 125 ml of a liquid colostrum whey product was supplemented for a relatively short period of 8 days, did not show an ergogenic effect on vertical jump performance. However, more recent studies by Buckley et al. did show ergogenic effects of colostrum on vertical jump (3), running performance (4), and rowing performance (5). These studies and the study of Mero et al. (10) were different in that a larger dose of colostrum was supplemented for a longer period. Buckley et al. provided 60 g of a low fat and low lactose concentrated bovine colostrum powder per day for a period of 8 weeks. To provide this amount of colostrum powder by liquid colostrum, an amount of about 700 ml liquid colostrum is required, which is about 5 to 6 times higher than the dose in the study of Mero et al. In addition an intensive training program was included during the supplementation period, directed towards the efficacy outcome parameters. No clear explanation of a mechanism for the ergogenic effect of colostrum supplementation was given in the studies of Mero et al. and Buckley et al. The present study was carried out to determine the effects of colostrum supplementation on various field exercise tests in elite field hockey players.

Methods

Study Design

Eighteen male and 17 female elite hockey players from a male and a female field hockey team participating in the Dutch national field hockey competition volunteered to participate in the study. Some of these elite athletes play in the Dutch national team. Each subject was randomly assigned to either the colostrum protein or whey protein group. The assignment was stratified towards the male and female hockey team because the female and male team trained separately. The study took place during the first half of the competition season, a period in which games took place on a regular basis and fluctuations in training volumes and intensities were the smallest. At baseline and after 8 weeks of supplementation, weight, height, body composition, and exercise performance were measured.

Training Volume and Frequencies

During the study period, there were 4 training sessions each week, including one field hockey game of 2 × 35 min, with 10 min of rest in between. The first training session of the week consisted of a field hockey game, which was characterized by high intensity interval exercises. The second training session of 90 min took place 2 days later and consisted of 45 min of power training of 3 × 10 to 3 × 20 repetitions of 40 to 60% of 1 repetition maximum. The remaining 45 min consisted mainly of sprint training. The third and fourth tactical training sessions, respectively, 1 and 3 days later consisted of high intensity interval exercises for a duration of 2 hours. Training frequencies and volumes were similar for male and female participants.

Colostrum and Whey Protein Supplementation

The composition of the colostrum preparation (Intact™, Northfield Laboratories Pty. Ltd., Adelaide, Australia) and whey protein were similar with respect to energy and protein content [colostrum (per 100 g): 376 kcal, 75 g protein, 11 g carbohydrates, and 3.5 g fat; whey (per 100 g): 379 kcal, 77 g protein, 11 g carbohydrates, 3.0

g fat]. As reported elsewhere, bioactive components like growth factors, immunoglobulins, and anti-microbial proteins are higher in colostrum (2, 8, 9, 11–13). Each subject received 60 g whey protein powder or colostrum powder daily for a total period of 8 weeks. The daily dose was provided in 3 sachets of 20 g each, one sachet to be taken during breakfast and two sachets to be taken during dinner. To assess the compliance of supplementation, each subject had to return unused sachets after the supplementation period.

Anthropometrics

At baseline and after 8 weeks, weight and skinfold thickness of biceps, triceps, subscapular, and suprailiac were measured by the same investigator. Equations of Durnin and Womersley (7) were used to assess fat mass and lean body mass. However, since these equations are not validated for field hockey players, the sum of the skinfolds also is reported.

Exercise Performance

Four different exercise performance tests were performed at baseline and after 8 weeks of supplementation. An overview of the major characteristics of these tests is shown in Table 1. These tests are routinely used to assess an elite athlete's physical condition.

1: Sprint Test. The subject had to run as fast as possible 5 times between 2 markers separated by 10 m. Total distance covered was 50 m. This test was performed twice with 30 min of rest in between. The fastest time was recorded.

2: Suicide Test. The subject had to run as fast as possible back and forth between 6 markers—that is, starting between marker 1 and 2 and followed by running between marker 1 and 3, 1 and 4, 1 and 5, and 1 and 6. The markers were 10 m apart in a straight line. Total distance covered was 300 m. This test was performed twice with 30 min of rest in between. The fastest time was recorded.

3: Shuttle Run Test. The subject had to run between two lines, separated by 20 m. The running speed was determined by a repetitive beep. At each sound, the subject had to be at the other line. The time between the sounds became shorter and therefore the subject had to run faster. The test started with a running speed of 8.0 km/h and

Table 1 Major Characteristics of Exercise Performance Tests (5)

Variable	Shuttle run	Suicide	Sprint	Vertical jump
Power production	Low	High	Higher	Highest
Energy system	Oxygen	Lactic acid	ATP-CP	ATP
Energy source	Muscle glycogen	Muscle glycogen	ATP-CP	ATP
Muscle fiber	Slow twitch	Fast twitch	Fast twitch	Fast twitch

gradually increased every minute by 0.5 km/h. Time to exhaustion was the performance measure.

4: Vertical Jump. This test was performed in a human physiology laboratory. Vertical jump height was measured electronically (Bosco Ergo Jump equipment) by measuring the flight time from when the subject's feet left contact with the switch mat until the feet again made contact with the mat. Contact was made with the mat whilst the subject's legs were straight. A countermovement of the arms was allowed. The test was performed 6 times in 2 series of 3 jumps, with 30 min of rest in between. The highest jump was recorded.

Statistical Analysis

To examine the change in parameters between measurements at baseline and at week 8 within the supplement groups, the parameters were analyzed by paired Student's *t* test.

To examine the between-supplement effects, each individual change in outcome parameter between baseline and week 8 was calculated, and these individual changes were analyzed by analysis of variance. Initially determined was whether any significant interaction existed between Sex and Supplement factors. Since no interaction was found, the between-supplement effects were analyzed with analysis of variance with Sex as the fixed factor. *P* values less than .05 were considered statistically significant. Baseline descriptive values are presented as mean ±*SD,* while other data are presented as mean ±*SEM*.

Results

Subjects

Eighteen subjects were included in the colostrum group (9 males and 9 females), and 17 subjects were included in the whey group (9 males and 8 females). Seven subjects could not complete the study of which 4 received the whey supplement and 3 received the colostrum supplement. One of the subjects who received the whey supplement had tolerance problems, and the other subjects stopped because of reasons not related to the supplements. (Five subjects had sports injuries, and 1 subject stopped playing hockey for the club.) Male and female specific characteristics of the remaining 14 males and 14 females are shown in Table 2. There were no significant differences between the colostrum and whey groups at baseline. The average intake of the supplements during the whole period of 8 weeks was 87 ± 14% (mean ± *SD*) of total requirement in the control group and 90 ± 8% of total requirement in the colostrum group. This is not a significant difference ($p = .591$).

Anthropometric Data

From baseline to week 8, weight and LBM significantly increased in both the whey group [weight: 1.0 ± 0.3 kg ($p < .01$), LBM: 1.2 ± 0.3 kg ($p < .01$)] and the colostrum group [weight: 1.1 ± 0.3 kg ($p < .01$), LBM: 1.3 ± 0.3 kg ($p < .01$)]. The fat mass and sum of skinfolds were not significantly reduced in the whey group [fat mass: –0.2 ± 0.4 kg ($p = .159$), skin folds: –3.9 ± 1.8 mm ($p = .063$)] and the colostrum group [fat mass: –0.2 ± 0.4 kg ($p = .382$), skin folds: –3.4 ± 1.6 mm ($p = .130$)]. No

Table 2 Male and Female Specific Subject Characteristics (Mean ± *SD*)

	Males		Females	
Variable	Colostrum	Whey	Colostrum	Whey
n	7	7	8	6
Age	23.4 ± 3.1	23.1 ± 3.8	21.9 ± 4.1	22.3 ± 2.1
Weight (kg)	79.3 ± 8.5	77.8 ± 7.4	65.2 ± 6.9	63.3 ± 5.1
Height (m)	1.83 ± 0.09	1.84 ± 0.04	1.69 ± 0.08	1.69 ± 0.09
BMI (kg/m^2)	23.7 ± 1.5	23.0 ± 1.6	22.8 ± 1.8	22.6 ± 1.3
Sum skinfolds (mm)	28.6 ± 7.3	25.7 ± 7.9	57.1 ± 17.8	56.5 ± 14.8
Fat mass (kg)	9.7 ± 3.2	8.4 ± 3.2	18.2 ± 4.7	17.6 ± 2.9
LBM (kg)	69.6 ± 5.8	69.4 ± 5.3	47.0 ± 3.8	45.7 ± 4.0

Table 3 Male and Female Specific Baseline Exercise Tests Performance (Mean ± *SD*)

	Males		Females	
Variable	Colostrum	Whey	Colostrum	Whey
Shuttle run (min)	11.5 ± 1.3 (*n* = 4)	11.3 ± 1.3 (*n* = 5)	10.2 ± 1.5 (*n* = 5)	10.0 ± 1.3 (*n* = 5)
Suicide (s)	57.8 ± 1.9 (*n* = 5)	57.2 ± 1.2 (*n* = 6)	69.6 ± 2.7 (*n* = 7)	69.6 ± 2.8 (*n* = 5)
Sprint (s)	11.2 ± 0.4 (*n* = 5)	11.1 ± 0.3 (*n* = 6)	15.6 ± 0.3 (*n* = 7)	15.5 ± 0.3 (*n* = 5)
Vertical Jump (cm)	51.5 ± 3.5 (*n* = 5)	48.4 ± 7.3 (*n* = 5)	32.1 ± 4.7 (*n* = 8)	34.5 ± 3.7 (*n* = 5)

significant differences in these changes between the colostrum and the whey groups were found.

Exercise Tests

Male- and female-specific exercise test baseline values of the colostrum and whey groups are shown in Table 3. The sex-corrected performance values at baseline and at week 8 are shown in Figure 1. There were no significant differences between the colostrum and whey groups at baseline. From baseline to week 8, there were no significant changes within groups in shuttle run performance (whey group: –0.5 ±

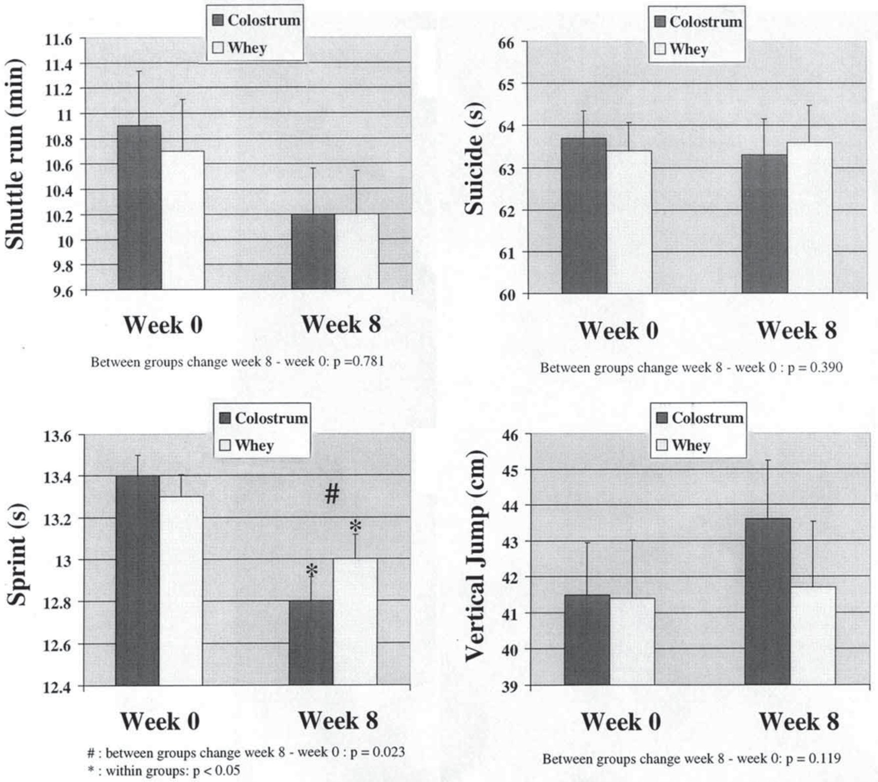

Figure 1 — For sex corrected values (mean + *SEM*) of shuttle-run performance, suicide test, sprint performance, and vertical jump performance at week 0 and week 8.

0.3 min and colostrum group: –0.6 ± 0.3 min) and suicide test (whey group: +0.17 ± 0.41 s and colostrum group: –0.33 ± 0.39 s). There were also no significant differences between the whey and colostrum groups for these parameters. Sprint performance was significantly improved from baseline to week 8 in both the whey [–0.33 ± 0.09 s ($p < .01$)] and the colostrum group [–0.64 ± 0.09 s ($p < .01$)], while the reduction in sprint time was significantly larger in the colostrum group than the whey group ($p = .023$). Vertical jump performance was not significantly improved from baseline to week 8 in the whey group (+0.32 ± 0.82 cm) and the colostrum group (+2.10 ± 0.73 cm). However, there was a trend ($p = .119$) towards a larger improvement in the colostrum group.

Discussion

This study examined the effect of colostrum supplementation on field exercise tests during the competitive season. These exercise tests are routinely used to assess the physical condition of athletes participating in sports, which are characterized by intermittent high intensity exercise like field hockey and soccer.

The principal finding of the present study was that sprint performance improved significantly more in subjects taking the colostrum supplement than those taking the placebo, and there was a strong trend towards more improvement in vertical jump performance in the colostrum group compared to the whey group. However, no effect was found on shuttle-run and suicide-test performance. The difference in increase in vertical jump performance between the colostrum and the whey group of 1.8 cm was of the same magnitude as the statistical significant difference of 1.6 cm ($p < .005$) found in Buckley's study (3) with 51 subjects. Therefore, it seems that the difference in vertical jump performance may be a real difference and that the lack of statistical significance in the present study was a matter of not having enough subjects.

The greater improvement in sprint and vertical jump performance in the colostrum group compared to the whey group could not be explained by differences in training volumes or frequencies. All the males as well as all the females followed the same training program, and randomization of subjects to either the colostrum or whey group was stratified for sex. The difference in sprint and vertical jump performance could neither be explained by differences in compliance of supplement intake nor in changes in LBM, since there were no differences in supplement intake and no differences in changes in LBM between the colostrum and the whey groups. It might have been expected that colostrum supplementation would increase LBM, since colostrum supplementation in animals has shown increased protein synthesis in skeletal muscle (6) and the small intestine (14) when compared with normal milk supplementation. Also, Antonio et al. (1) showed that a daily consumption of 20 g of bovine colostrum resulted in a significant increase (mean increase of 1.49 kg) in bone-free lean body mass in active men and women, while there was no increase in the whey powder group. Although the dose of 20 g was lower than that used in the current study, the subjects in the study of Antonio et al. were not elite athletes. It is therefore speculated that elite field hockey players would have a much more difficult time gaining lean body mass than individuals who were less fit. In addition, the anabolic action of bioactive components in colostrum may not have been strong enough to have an additive effect upon the anabolic effect of whey supplementation and training, since supplementation of 60 g of whey each day already resulted in a significant increase in LBM.

The reason for the difference in effect of colostrum supplementation on exercise activities relying on the ATP-CP system (i.e., sprint, vertical jump) and oxygen/lactic acid system (shuttle run, suicide run) could be due to the type of training undertaken. Our study design was comparable to studies by Buckley et al. (3–5). That is, we used a double-blind, placebo-controlled, 8-week intervention in which subjects ingested 60 g of whey protein or colostrum protein. During the supplementation period, the subjects participated in an intensive training program that consisted of running (4), resistance exercise (3), or rowing (5). The subjects improved the type of exercise performance, which was in line with the training program—that is, a second bout of maximal running performance (4), vertical jump performance (3), and rowing performance (5). In our field experiment, the first half of the competitive training season focused on improving game-related activities such as interval and sprint performance. So it seems that the ATP-CP energy system was trained more than the oxygen energy system. The mechanism(s) by which colostrum exerts ergogenic effects is not known; however, one could speculate that colostrum supplementation improves those physiological or metabolic processes, which are trained intensively.

During the sprint test, each subject performed the same amount of work (neglecting the small increase in weight). Since sprint time decreased average power increased. This indicates a greater rate of CP and ATP dephosphorylation; therefore, it is tempting to speculate that colostrum supplementation might have stimulated or supported the CP and ATP dephosphorylation.

It is concluded that in elite field hockey players, colostrum supplementation improves sprint performance better than whey, whereas there is a strong trend towards a larger increase in vertical jump. Colostrum supplementation did not affect endurance exercise performance. The greater improvement in sprint performance occurred in the absence of a greater increase in LBM. Although the mechanism is unclear, it is speculated that colostrum might stimulate CP and ATP dephosphorylation in specific tissues that are trained most intensively.

References

1. Antonio, J., M.S. Sanders, and D. Van Gammeren. The effects of bovine colostrum supplementation on body composition and exercise performance in active men and women. *Nutrition* 17:243-247, 2001.
2. Aranda, P., L. Sanchez, M. Perez, J.M. Ena, and M. Calvo. Insulin in bovine colostrum and milk: evolution throughout lactation and binding to caseins. *J. Dairy Sci*. 74:4320-4325, 1991.
3. Buckley, J.D., M. Abbott, G. Brinkworth, and P. Whyte. Oral supplementation with bovine colostrum (Intact) increases vertical jump performance. *4th Annual congress of the European College of Sport Science*, Rome, 1999, p. 658.
4. Buckley, J.D., M.J. Abbott, G.D. Brinkworth, and P.B.D. Whyte. Bovine colostrum supplementation during endurance running training improves recovery, but not performance. *J. Sci. Med. Sport*. In press.
5. Buckley, J.D., G.D. Brinkworth, P.C. Bourdon, J. Gulbin, E.J. Stilwell, A. David, and N. Myers. Oral supplementation with bovine colostrum (Intact) improves rowing performance in elite female rowers. *5th IOC World Congress of Sports Sciences,* Sydney, 1999.
6. Burrin, D., R. Shulman, P. Reeds, T. Davis, and K. Gravitt. Porcine colostrum and milk stimulate visceral organ and skeletal muscle protein synthesis in newborn pigs. *J. Nutr*. 122:1205-1213, 1992.
7. Durnin, J.V.G.A., and J. Womersley. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged 16 to 72 years. *Br. J. Nutr*. 32:77-97, 1974.
8. Malven, P.V., H.H. Head, R.J. Collier, and F.C. Buonomo. Periparturient changes in secretion and mammary uptake of insulin and concentrations of insulin and insulin-like growth factors in milk of dairy cows. *J. Dairy Sci*. 70:2254-2265, 1987.
9. Marcotty, C.F., J. Frankenne, G.v. Beeumen, G. Maghuin-Rogister, and G. Hennen. Insulin-like growth factor I (IGF-I) from cow colostrum: purification and characterisation. *Growth Regulat*. 1:56-61, 1991.
10. Mero, A., H. Mikkulainen, J. Riski, R. Pakkanen, J. Aalto, and T. Takala. Effects of bovine colostrum supplementation on serum IGF-I, IgG, hormone and saliva IgA during training. *J. Appl. Physiol*. 83:1144-1151, 1997.

11. Oda, S., H. Satoh, T. Sugawara, M. Matsunaga, T. Kuhara, K. Katoh, Y. Shoji, A. Nihel, M. Ohta, and Y. Sasaki. Insulin-like growth factor-I, GH, insulin and glucagon concentrations in bovine colostrum and in plasma of dairy cows and neonatal calves around parturition. *Comp. Biochem. Physiol.* 94:805-808, 1989.
12. Pakkanen, R., and M. Neutra. Bovine colostrum ultrafiltrate—an effective supplement for the culture of mouse-mouse hybridoma cells. *J. Immunol. Methods* 169:63-71, 1994.
13. Skaar, T.C., J.R. Vega, S.N. Pyke, and C.R. Baumrucker. Changes in insulin-like growth factor-binding proteins in bovine mammary secretions associated with pregnancy and parturition. *J. Endocrin.* 131:127-133, 1991.
14. Tungthanathanich, P., R.J. Xu, G.W. Reynolds, and H.V. Simpson. The effect of milk diets on small intestinal growth in newborn piglets. *Proc. Nutr. Soc. NZ.* 17:51-55, 1992.
15. Williams, M.H. *The Ergogenics Edge*. Champaign, IL: Human Kinetics, 1998.

Acknowledgments

We would like to thank Dr. Ir. L.R. Verdooren for his statistical advice and Drs. D.J.C. Meenhorst for her practical support. We would also like to thank all the field hockey players who volunteered to participate in this study.