Investigation of serum insulin and cortisol concentrations in and mouth disease- infected cattle in relation to changes in se biochemical variables and protein electrophoretic fractiona profile.

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Abstract
The present study was conducted to monitor serum levels of insulin and cortisol and mouth disease-infected cattle (FMD) in relation to possible alterations in biochemical variables and protein electrophoretic fractionation. The study was c out on two groups of cattle one group of 15 naturally infected FMD cattle and a group of 8 healthy cattle were used as control. Evaluating parameters included levels of insulin and cortisol, biochemical variables [total protein (TP), albumin glucose, serum calcium (Ca), serum phosphorous (P), blood urea (BUN), creatinine (Cr) and serum enzymatic activities of alanine amino transferase (AL aspartate amino transferase (AST)] as well as serum protein electrophoresis results showed a significant increase in serum levels of glucose, chole phosphorus, AST and cortisol and a significant decrease in serum concentra total protein, calcium and insulin. Serum protein electrophoretic fractionation sho significant decrease in albumin and gamma globulins. There was a sign negative correlation between insulin and serum levels of glucose, chole phosphorus and cortisol and significant positive correlation with serum lev calcium and total proteins. Serum cortisol concentration was positively correlate serum levels of glucose, phosphorus and AST and negatively correlated with al calcium and insulin.Our results indicate that FMD infection in cattle res pancreatic dysfunction and hypoinsulinemia as well as a pronounced stress res as detected by the significant increase in cortisol levels. Further, alterations biochemical variables and protein electrophoresis seen in FMD group are likely to be related to changes in serum concentrations of these two hormones prov further understanding of the disease process and clinical pathology of FMD in ca

Introduction

Animals undergoing any challenge to their state of health as infection, inflam trauma and systemic body illness react by a wide range of nona pathophysiologic responses collectively known as the acute phase response illness (Eckersall, 2000).The acute phase response is considered to be a d process involving systemic and metabolic changes providing an early nons defence mechanism against insult before specific immunity is achieved (Pete al., 2004). This response encompasses diverse countermeasures combining t to minimize tissue damage while enhancing the repair process including p changes clinically characterized by fever, anorexia and negative nitrogen b (Moshage, 1997and Gruys et al., 2005). In addition, a series of changes in blo can be measured in the laboratory such as changes in leukocyte numbers in changes in host's metabolic responses as indicated by disturbances in concentrations of proteins, lipids and carbohydrates, hormonal alterations, inc

values of adrenocorticotrophic hormone (ACTH) and glucocorticoids and cha concentration in a number of serum proteins known as the acute phase pr (Ramaekers et al., 1975; Baumann and Gauldie, 1994; Kushibiki et al., Ganheim et al., 2003; Ametaj et al., 2005; Gruys et al., 2005 and Fagliari et al., The magnitude of this response varies with type and severity of illness which de on the severity of insult, the type and strain of infectious agent, pathology insi body, infective dose and status of host (Ramaekers et al., 1975).

Foot and mouth disease (FMD) also known as aphthous fever is a communicable disease and one of the most serious livestock diseases that affe cloven-footed domestic and wild animals including cattle, buffalo, camels, s goats, deer and pigs (Blancou, 2002 and Radostits et al., 2007). It is caused by the smallest disease producing viruses known as Aphthovirus or foot and diseases virus (FMDV) which is a member of the Family Picornovirus (Radostits 2007). The disease is characterized by blister-like lesions on the tongue, nose, the mouth, on the teats and between the toes which then burst, leaving painful u Affected animals usually have high fevers, stop eating, give less milk and be lame (Barnett and Cox,1999 and Remond et al., 2002). On most continents, catt usually the most important maintenance hosts for FMDV, but some virus strain primarily found in pigs, sheep or goats (Lubroth, 2002 and Radostits et al., 2 While FMD is not a concern for human health, it can cause severe problem animals with cloven hooves with the potential of causing severe economic losse trade disruptions in animals and animal products (Lubroth, 2002). Many studies addressed the cellular and humoral basis of immunity to FMDV or the influen infection on the regulation of the immune response (Knudsen et al., 1979; McCul et al., 1986; McCullough et al., 1992 and Baxt and Mason, 1995).

Fewer studies have studied the hematological and biochemical changes asso with FMD infection in cattle (Yeotikar et al., 2003; Gokce et al., 2004 and El-Sa al., 2007) but to the best of our knowledge effect of FMD on serum concentratio insulin and cortisol as well as serum profile of protein electrophoresis in FMD inf cattle are not well documented. Consequently, the present investigation aim monitor the possible alterations in serum insulin and cortisol levels in FMD inf cattle in relation to changes in some biochemical variables and serum profile of p electrophoretic fractionation in these patients.

Materials and Methods

Cattle: Two groups of cattle were used in this study, one consisted of 15 nat affected FMD cases showed characteristic clinical signs of FMD based on r clinical examination and observation of the characteristic lesions. Animals w characteristic lesions for FMD were not used in the study. The other group consis 8 being clinically healthy cattle and were used as controls.

Blood samples: Blood samples were collected from the animals of both groups serum samples were stored at -20°C until used for different assays described i study.

Biochemical parameters:

Serum samples were evaluated for the concentration of total protein (TP), alb (Alb), glucose, cholesterol (Chol), calcium (Ca), phosphorus (P), blood urea nitr (BUN), creatinine (Cr) and serum enzymatic activities of alanine aminotransf (ALT) and aspartate aminotransferase (AST). All biochemical parameters determined by spectrophotometric method using commercial kits.

Hormonal assays:
Serum levels of insulin and cortisol were determined by enzyme-linked immunosorb assay (ELISA) using commercially available test kits of Hellabio diagnostics comp and following the manufacturer's instructions.

Serum protein electrophoresis:
Electrophoretic separation of serum proteins was accomplished by an agaros gel electrophoresis using commercially kits of Cobasintegra company and following the manufacturer's instructions.

Statistical analysis:
All the values were presented as mean± standard deviation (SD). Mean value FMD infected group and control group were compared by Student's t-test at level of probability. Differences at $p<0.05$ were considered significant. Correlat between monitored variables were determined with Pearson's simple correl method. A difference was considered significant at $P < 0.05$.

Results

Serum biochemical parameters:
Results of serum biochemical tests as shown in (table 1) revealed that there w significant decrease in serum total proteins ($P<0.05$) in FMD-infected group comp to the control one. Comparison of the mean values for blood glucose between the groups showed a significant increase ($P<0.001$) in glucose level in the FMD-infe cattle. The mean values of serum cholesterol were significantly higher ($P<0.001$) i FMD-infected group. Serum calcium concentration showed a significant decr ($P<0.05$) in the FMD-infected cattle while, serum phosphorus was signific increased ($P<0.05$) . The mean values of serum BUN and creatinine in FMD-infe and healthy cattle were similar. Comparison of the mean values of serum enzy activities of ALT and AST demonstrated a significant increase ($P<0.01$) in serum and no significant changes were seen in serum ALT activity.

Hormonal assays:
The mean values of serum insulin levels were significantly lower ($P<0.05$) in the F infected group while serum cortisol levels showed a significant increase ($P<0.01$) (2).

There was a significant negative correlation between insulin and serum leve glucose, cholesterol, phosphorus and cortisol (R= 0.887, 0.839, 0.891 and respectively) and significant positive correlation with serum levels of calcium and proteins (R= 0.834 and 0.923 respectively) (table 4). Serum cortisol concentratior positively correlated with serum levels of glucose, phosphorus and AST (R= 0 0.976 and 0.957 respectively) and negatively correlated with albumin, calcium insulin (R = 0.859 0.911 and 0.902 respectively).

Serum protein electrophoretic fractionation:
The major changes observed in the electrophoretic pattern of FMD infected included significant decrease in both albumin and gamma globulins ($P<0.05$) (tabl

Table 1. Mean values ± SD of serum biochemical parameters in the FMD- infecte cattle compared to the control group. Values are means ± SD.

Variable	Control group	FMD infe
group		
Total protein (g/dl)	7.85±0.11	6.58±0.07

Glucose (mg/dl)	62.43±5.53	106.37±7
Cholesterol (mg/dl)	125.40±17.09	196.12±21
Calcium (mg/dl)	13.43±2.18	10.95±1.5
Phosphorous (mg/dl)	5.30±0.30	6.39±1.1
ALT (U/l)	58.27±1.32	57.17±3
AST (U/l)	137.00±4.95	153.84±
BUN (mg/dl)	17.57±1.41	18.18±0
Creatinine (mg/dl)	1.39±0.21	1.43±0.30

Significant differences in the values between the FMD and control groups are indicated by * P < 0.05, ** P < 0.01, *** P < 0.001.

Table 2. Serum insulin and cortisol concentrations in the FMD- infected cattle compared to the control group. Values are means ± SD.

Hormone group	Control group	FMD infe
Insulin (µIU/ml)	15.90±2.50	11.93±1.0
Cortisol (µg/dl)	1.43±0.07	2.65±0.2

Significant differences in the values between the FMD and control groups are indicated by * P < 0.05, ** P < 0.01.

Table 3. Serum profile of protein electrophoretic fractionation in the FMD- infecte cattle compared to the control group. Values are means ± SD.

Variable	Control group	FMD infected grou
Total protein (g/dl)	6.58±0.07*	7.8
Albumin (g/dl)	2.90±0.10*	3.4
Alpha 1 globulin (g/dl)	0.36±0.11	0.5
Alpha 2 globulin (g/dl)	0.86±0.03	0.70±
Beta globulin (g/dl)	0.83±0.07	0.8
Gamma globulin (g/dl)	1.65±0.09*	2.4

Significant differences in the values between the FMD and control groups are ind by * P < 0.05.

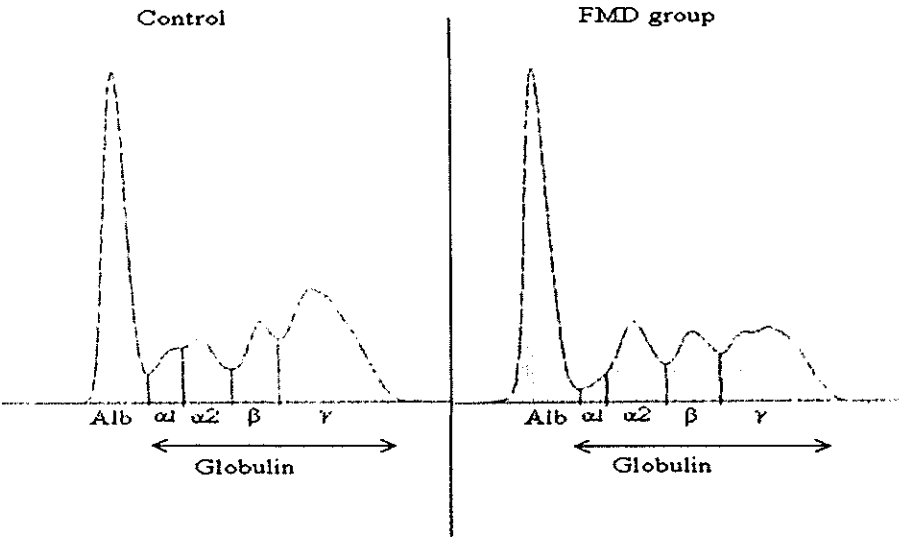

Figure 1. Schematic representation of protein electrophoresis agarose gel in FMD infected cattle compared to control group.

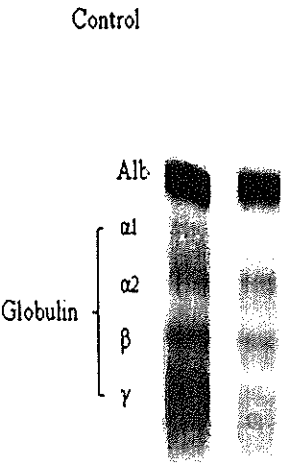

Figure 2. Autoradiogram of protein electrophoresis agarose gel in FMD infe cattle compared to control group

Discussion

FMD is a severe, highly contagious viral disease which is most importar domesticated and wild cloven-hoofed animals, notably cattle, pigs, goats, buffalo, sheep (Radostits et al., 2007).
The disease is characterized by fever and vesicles (blisters) on the feet, in and ar the mouth, and on the mammary gland. Vesicles often rupture rapidly, beco erosions. Pain and discomfort from the lesions leads to a variety of symptoms incl depression, anorexia, excessive salivation, lameness and reluctance to move or (Radostits et al., 2007). Where it is endemic, this disease is a major constraint t international livestock trade because it has grave economic losses in the productic meat and milk as well as clinical consequences (Lubroth, 2002). In our study characteristic clinical signs seen in the FMD-infected cattle comply with those finc recorded in previous reports (Yang et al.,1999; Blancou, 2002; Paarlberg et al., and Remond et al., 2002).
The results of the present investigation revealed that in the FMD group, s concentrations of glucose significantly increased (P<0.001). Hyperglycemia common finding and well documented in cattle affected with FMD (Szopa et al., 1 Elitok et al.,1999; Yeotikar et al., 2003; Gokce et al., 2004 and El-Saied et al., 2(Sustained increases in glucose can be seen with insulin deficiency due to pancr beta cell (β cells) dysfunction (type I diabetes mellitus) or insulin resistance (ty diabetes mellitus) (Jun and Yoon, 2001 and Clark, 2003). Like some other viruse both naturally occurring and experimental infections, FMDV has been implicated ir development of type 1 diabetes by 2 different mechanisms. First the virus can dir destroy insulin-producing pancreatic β cells in the pancreas due to viral replic (Barbni et al.,1966 and Jun and Yoon, 2001). Second, an immune response ag the virus infection may induce an autoimmune response in the host leadin destruction of the remaining β cells (Craighead and Steinke, 1971; Boucher Notkins,1973 and Jun and Yoon, 2001). Both mechanisms will result in decre insulin synthesis and thus hyperglycemia (Jun and Yoon, 2001). Therefore, to whether hyperglycemia might be attributed to decreased insulin synthesis, s levels of insulin were determined. The demonstration of significant lower leve insulin in the serum of FMD infected cattle than in appropriate controls ($P < 0.05$) the significant negative correlation (R= -0.887, $P < 0.05$) between serum leve insulin and serum glucose concentration (table 4) supports the contention tha FMD-induced hyperglycemia is, at least in part, secondary to insulin deficiency and Yoon, 2001).

Insulin resistance can be a result of increased cortisol concentration that oppose action of insulin on peripheral tissues resulting in hyperglycemia (Coles, 1986; Rou et al., 1997; Meyer and Harvey,1998 and Lassen, 2004). Because cattle ten produce marked stress hyperglycemia (Kaneko et al., 1997), the significant increas serum cortisol levels seen in the present work may provide another reason fo significantly higher glucose levels in FMD- infected group. This explanation is fu supported by the significant negative correlation between cortisol and insulin levels -0.902, $P < 0.05$) and the significant positive correlation between cortisol and glu levels (R= 0.970, $P < 0.05$) (table 4). There is also a hypothesis that the increas blood glucose concentration in FMD-infected cattle may be a response hypocalcemia because an adequate amount calcium ions in extracellular fluic essential for insulin secretion in response to blood glucose so, hypocalca interferes with the secretion of insulin from the pancreas (Kaneko et al., 1

Moore,1997 and Gokce et al., 2004). We reported a significant positive correl between calcium and insulin levels (R= 0.834, $P < 0.05$) that may support hypothesis (table 4).

A significant reduction in serum TP ($P<0.05$) and albumin ($P<0.05$) was recorded i FMD group. Protein requirement as well as protein catabolism increase ir presence of infection or any lesions on the body (Roussel et al.,1997 and Meye Harvey,1998). Anorexia and off food due to mouth lesions that characterize cattle FMD may be in part a possible cause (Lubroth, 2002 and Gokce et al., 2004). It is well known that glucocorticoids are closely involved in the protein metabolism eith their antianabolic effect reducing protein synthesis or catabolic action incre breakdown (Kaneko et al., 1997). Albumin degradation also is increased i presence of increased glucocorticoids and may exceeds synthesis which will lea decrease in serum total protein and albumin concentrations (Coles, 1986 and Ka et al., 1997).

Consumption of protein has also been found to be associated with hypoinsulir and diabetes mellitus (Moore,1997; Roussel et al.,1997 and Meyer Harvey,1998).Therefore, hypoinsulinemia may in part explain the decrease in protein concentrations observed in this study as detected by the significant po correlation between serum TP and insulin levels (R= 0.923, $P < 0.01$).

Despite the fact that liver disease is one of the most important causes of decr serum total proteins, liver dysfunction was not recorded in this study as detect normal serum activity of ALT a specific marker for liver disease. Serum activity o was significantly increased ($P<0.01$). Elevation in serum AST may be associate stressful conditions and glucocorticoid excess (Kaneko et al., 1997) so incr serum AST activity can be attributed to increased serum cortisol levels (Corre between cortisol and AST was indicated as R= 0.957, $P<0.01$).

A significantly high level of cholesterol, ($P<0.01$) was detected in serum sa obtained from cattle with FMD. Abnormalities in lipid metabolism may be seconc insulin deficiency (coles, 1986 and Kaneko et al., 1997). In the absence of i lipolysis is enhanced and plasma free fatty acids concentrations rise (Kaneko 1997).Very low density lipoproteins (VLDLs) accumulate in plasma becau catabolism requires insulin for optimal activity which are converted in the bloods to low density lipoproteins (LDLs). The rate of cholesterol synthesis is increase an associated increase in plasma LDLs concentration (Kaneko et al., 1997).

Significant negative correlation between insulin and cholesterol (R= 0.839, P was detected in the present study.

Serum calcium values were significantly decreased in FMD group compared to in the control group. Hypoproteinemia and hypoalbuminemia resulting in dec protein bound calcium and may contribute to the hypocalcemia (Moore, 1997; R et al.,1997 and Gokce et al., 2004). Significant positive correlation between c and TP was reported as R= 0.870, $P<0.05$.

Cortisol also has been found to produce marked depression of Ca uptake from g to inhibition of vitamin D (Kaneko et al., 1997). Significant negative correlation be cortisol and Ca was indicated as R= -0.911, $P<0.05$.

Serum phosphorous was significantly increased in the FMD group may be hypocalcemia based on the mass law of interaction between calcium and phosp hypocalcemia leads to a reciprocal increase in the serum phosphorus concer (Meyer and Harvey 1998). Significant negative correlation between Ca and indicated as R= -0.911, $P<0.05$.

In the present study a significant high serum concentration of cortisol was reco Stress due to febrile conditions, systemic infection and general body illnes associated with increase in adrenal activity resulting in increased glucocorticoid l (Chase et al., 1995; Adcock Torpy and Ho, 2007). Cortisol is the major glucocor known as the critical stress hormone whose levels are increased in respon stressful conditions and is considered a part of the host's response to abn events particularly in the acute phase of the illness (Ramaekers et al., 1975; Ro 1995; Gruys et al., 2005 and Moolchandani et al., 2008).

The current findings of protein electrophoresis in FMD infected cattle reveal significant decrease in gamma globulins (fig.1, 2). Cortisol is known to weak suppress the activity of the immune system by inhibiting lymphoid mitosis and red immune cell number and function (Ramaekers et al., 1975; Campbell and Coles, and Meyer and Harvey, 1998).) In the present study, significant negative correl (results not shown) between serum levels of cortisol and gammaglobulin was rec (R= -0.851, $P<0.05$) which indicates that excess cortisol may inhibit anti production and can result in decreased gammaglobulin concentrations an effec usually occurs before specific immunity is achieved (Roman, 1995 and Cab 2007).

In conclusion , infection of cattle with FMDV results in hypoinsulinemia which indicate the development of pancreatic dysfunction in these patients. In add FMDV infection induces a prominent stress response as indicated by the signif increase in serum cortisol levels. Further, it seems likely that the alterations t place in biochemical variables and protein electrophoresis in FMD-infected group be closely connected with changing in serum insulin and cortisol concentrations appeared to be related to the magnitude of this alteration obviating the importan considering or even the need for measurement of these two hormones in FMD c Finally, the present findings may provide a better understanding of the disease pro and clinical pathology of FMD in cattle.

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ركيزات الانسولين والكورتيزول في الابقار المصابه بالحمي القلاعيه وعلاقتها بالتغيرات في المتغيرات البيوكميانيه والفصل الكهربي للبروتين

ذه الدراسه لتقييم تركيز الانسولين والكورتيزول في مصل الابقار المصابه بالحمي القلاعيه وعلاقته بالتغيرات ي بعض المتغيرات البيوكميانيه والفصل الكهربائي للبروتين وقد تم اجراء الدراسه علي مجموعتين من الابقار داهما من ١٥ بقرة مصابه بالحمي القلاعيه بينما تكونت الاخري من ٨ بقرات سليمه وقد شملت الاختبارات ،بين نسب كل من الانسولين ، الكورتيزول ، البروتين الكلي ، الالبيومين ، الجلوكوز ، الكالسيوم ، الفسفور ، ، الكرياتنين ، خمائر الالانين والاسبرتات امينوترانسفيريز بالاضافه الي الفصل الكهربائي للبروتين .

ت النتائج حدوث نقصا معنويا في كل من الانسولين ، البروتين الكلي ، الكالسيوم في الحيوانات المصابه مقارنه ، السليمه وحدوث زياده معنويه في كل من الكورتيزول ، الجلوكوز ، الكوليستيرول ، الفسفور ، خمائر الاسبرتات

ت نتائج الفصل الكهربائي للبروتين حدوث نقصا معنويا في كل من الالبيومين وجلوبيولينات جاما وعن علاقه رات بنسب الانسولين والكورتيزول فقد اظهرت الدراسه وجود علاقه معنويه ايجابيه بين هرمون الانسولين وبين كالسيوم والبروتين الكلي واخري معنويه سلبيه بين الانسولين ومستويات الجلوكوز ، الكوليستيرول ، الفوسفات ول وبالنسبه لهرمون الكورتيزول اظهرت النتائج وجود علاقه معنويه ايجابيه بين الكورتيزول وكل من والفوسفات وخمائر الاسبرتات بينما وجدت علاقه معنويه سلبيه بين الكورتيزول وكل من الالبيومين والكالسيوم

ه ان هذه الدراسه تبين ان اصابه الابقار بمرض الحمي القلاعيه ينتج عنه خلل في وظائف البنكرياس وانخفاض ات الانسولين بالاضافه الي زياده معنويه في هرمون الكورتيزول وان معظم التغييرات الحادثه في بيوكيمياء الدم بطه بالتغير المرأي في هذه الهرمونات مما يتطلب وضع هذه الهرمونات بعين الاعتبار عند تقييم الاختبارات ي الابقار المصابه بالحمي القلاعيه وهذه النتائج قد تساعد علي فهم اكبر لطبيعه المرض في الابقار .

Table 4. The correlation between the selected hormones and biochemical variables in the FMD infected group (Pearson's correlation test).

Parameter	Insulin	Cortisol	Glucose	Cholesterol	TP	Alb	Ca	P	ALT	AST	BUN	Creatinine
Insulin	1	-0.902*	-0.887*	-0.839*	0.923**	0.700	0.834*	-0.891*	0.671	-0.931**	-0.0434	-0.530
Cortisol	-0.902*	1	0.957**	0.788	-0.780	-0.859*	-0.911*	0.976*	-0.350	0.957*	0.654	0.590
Glucose	-0.887*	0.957**	1	0.867*	-0.843*	-0.836*	-0.953**	0.989**	-0.311	0.982**	0.671	0.430
Cholesterol	-0.839*	0.788	0.867*	1	-0.909*	-0.636	-0.848*	0.873*	-0.572	0.923**	0.248	0.082
TP	0.923**	-0.780	-0.843*	-0.909*	1	0.614	0.870*	-0.811	0.624	-0.882*	0.337	-0.329
Alb	0.700	-0.859*	-0.836*	-0.636	0.614	1	0.891*	-0.899*	-0.036	-0.843*	-0.855*	-0.540
Ca	0.834*	-0.911*	-0.953**	-0.848*	0.870*	0.891*	1	-0.911*	0.246	-0.918**	-0.620	-0.473
P	-0.891*	0.976*	0.989**	0.873*	-0.811	-0.899*	-0.911*	1	-0.369	0.989**	0.614	0.404
ALT	0.671	-0.350	-0.311	-0.572	0.624	-0.036	0.246	-0.369	1	-0.472	0.338	-0.118
AST	-0.931**	0.957**	0.982**	0.923**	-0.882*	-0.843*	-0.918**	0.989**	-0.472	1	0.536	0.372
BUN	-0.0434	0.654	0.671	0.248	0.337	-0.855*	-0.620	0.614	0.338	0.536	1	0.534
Creatinine	-0.530	0.590	0.430	0.082	-0.329	-0.540	-0.473	0.404	-0.118	0.372	0.534	1

Indexes show statistical significance of correlations: * ($P \leq 0.05$); ** ($P \leq 0.01$).