

UNIVERZITET U SARAJEVU - VETERINARSKI FAKULTET



Adaptacioni mehanizmi domaćih životinja na termalni stres

Završni rad

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Adaptation Mechanisms of Domestic Animals to Thermal Stress

Diploma Thesis

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SAŽETAK

Termalni stres predstavlja značajan izazov za domaće životinje jer odstupanja temperature okoline izvan granica termoneutralne zone mogu narušiti sposobnost organizma da održava tjelesnu temperaturu i homeostazu. U zavisnosti od smjera temperaturnog opterećenja, razlikuju se toplotni i hladni stres. Cilj ovog rada bio je prikazati najvažnije fiziološke, hormonalne, metaboličke, ponašajne, morfološke, genetske i molekularne mehanizme kojima se domaće životinje prilagođavaju nepovoljnim temperaturnim uslovima, kao i analizirati posljedice termalnog stresa na njihovo zdravlje, dobrobit, proizvodne i reproduktivne sposobnosti.

Odgovor životinje na visoke i niske ambijentalne temperature uključuje međusobno povezane mehanizme termoregulacije. Kod toplotnog stresa organizam povećava odavanje toplote putem vazodilatacije, respiratornih i evaporativnih mehanizama, uz istovremeno smanjenje fizičke aktivnosti i unosa hrane. Suprotno tome, hladni stres dovodi do periferne vazokonstrikcije, smanjenja gubitka toplote, drhtanja i aktiviranja metaboličkih procesa usmjerenih na povećanje stvaranja toplote. Hormonalne promjene omogućavaju prilagođavanje energetskeg metabolizma i termoregulacionog odgovora, dok metaboličke adaptacije usmjeravaju raspoloživu energiju prema održavanju tjelesne temperature. Na molekularnom nivou, toplotni stres aktivira proteine toplotnog šoka i antioksidativne mehanizme, dok se pri hladnom stresu aktiviraju procesi termogeneze, uključujući ulogu smeđeg masnog tkiva i proteina UCP1.

Analizom morfoloških i genetskih mehanizama utvrđeno je da sposobnost prilagođavanja zavisi i od veličine i oblika tijela, karakteristika dlake i kože, količine potkožnog masnog tkiva te genetske varijabilnosti između vrsta i pasmina. Savremena genomska istraživanja omogućavaju identifikaciju gena povezanih sa termotolerancijom, dok selekcija i planski uzgoj mogu doprinijeti stvaranju populacija bolje prilagođenih nepovoljnim klimatskim uslovima. Poseban značaj imaju lokalne i autohtone pasmine koje predstavljaju važan genetski resurs za buduće programe prilagođavanja klimatskim promjenama.

Termalni stres, ukoliko traje dovoljno dugo ili je dovoljno intenzivan, može dovesti do smanjenja proizvodnih i reproduktivnih sposobnosti, poremećaja imunološke funkcije i narušavanja dobrobiti životinja. Zbog toga je za očuvanje zdravlja i produktivnosti domaćih životinja neophodan integrisani pristup koji kombinuje genetsku otpornost sa odgovarajućim smještajem, ishranom,

dostupnošću vode, ventilacijom i zaštitom od temperaturnih ekstrema. Razumijevanje međusobno povezanih mehanizama adaptacije predstavlja osnovu za razvoj održivijih sistema stočarske proizvodnje u uslovima promjenjive klime.

Ključne riječi: termalni stres, toplotni stres, hladni stres, termoregulacija, adaptacija

SUMMARY

Thermal stress represents a significant challenge for domestic animals because deviations of ambient temperature beyond the limits of the thermoneutral zone may impair the organism's ability to maintain body temperature and homeostasis. Depending on the direction of the thermal challenge, heat stress and cold stress can be distinguished. The aim of this study was to present the most important physiological, hormonal, metabolic, behavioural, morphological, genetic, and molecular mechanisms by which domestic animals adapt to unfavourable thermal conditions, as well as to analyse the effects of thermal stress on their health, welfare, productive and reproductive performance.

The study demonstrates that the response of animals to high and low temperatures involves interconnected thermoregulatory mechanisms. During heat stress, the organism increases heat dissipation through vasodilation, respiratory and evaporative mechanisms, while simultaneously reducing physical activity and feed intake. In contrast, cold stress induces peripheral vasoconstriction, reduces heat loss, stimulates shivering, and activates metabolic processes aimed at increasing heat production. Hormonal changes facilitate the adaptation of energy metabolism and thermoregulatory responses, while metabolic adaptations direct available energy towards the maintenance of body temperature. At the molecular level, heat stress activates heat shock proteins and antioxidant mechanisms, whereas cold stress activates thermogenic processes, including the involvement of brown adipose tissue and the UCP1 protein.

The analysis of morphological and genetic mechanisms showed that the ability to adapt also depends on body size and shape, characteristics of the hair coat and skin, the amount of subcutaneous adipose tissue, and genetic variability among species and breeds. Modern genomic research enables the identification of genes associated with thermal tolerance, while selection and planned breeding can contribute to the development of populations better adapted to unfavourable climatic conditions. Particular importance is attributed to local and indigenous breeds, which represent an important genetic resource for future adaptation programmes in response to climate change.

Thermal stress, when sufficiently prolonged or intense, may lead to reduced productive and reproductive performance, impaired immune function, and compromised animal welfare.

Therefore, maintaining the health and productivity of domestic animals requires an integrated approach that combines genetic resilience with appropriate housing, nutrition, water availability, ventilation, and protection from temperature extremes. Understanding the interconnected mechanisms of adaptation provides a basis for the development of more sustainable livestock production systems under changing climatic conditions.

Keywords: thermal stress, heat stress, cold stress, thermoregulation, adaptation, domestic animals