

Aloe vera gel and ascorbic acid promote collagen synthesis in mirror carp (*Cyprinus carpio* var. *specularis*)

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Abstract

This study aimed to assess the effects of dietary aloe vera gel and ascorbic acid (VC) on collagen content and flesh quality in mirror carp. The results indicated that dietary supplementation with aloe vera gel and VC significantly increased collagen content in both skin and muscle tissues. In skin tissue, aloe vera gel and VC enhanced collagen synthesis by up-regulating transforming growth factor- β (TGF- β)/Smads gene transcription. In muscle tissue, increased collagen synthesis appeared to be associated with the up-regulation of tor, s6k1, and 4e-bp3 transcription. Aloe vera gel modified the composition of free amino acids in fish meat, reducing the content of bitter amino acids, which may contribute to an improved flavor profile. The analysis of differentially expressed proteins (DEPs) and enriched KEGG pathways suggested that regulatory effects of aloe vera gel and VC involved multiple cell processes, particularly protein processing in the endoplasmic reticulum and ECM-receptor interaction pathways. Notably, the polysaccharides in aloe vera gel may increase the availability of precursors for glycosaminoglycan synthesis, with N-acetylglucosamine, UDP-galactose, and GDP-mannose playing crucial roles. Overall, these findings suggest a promising nutritional strategy to enhance fish meat quality and potentially add value to fish products by dietary interventions.

Results

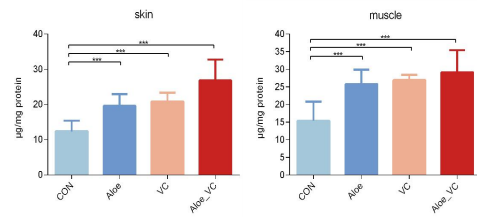


Fig. 1. The contents of collagen in the skin and muscle tissues.

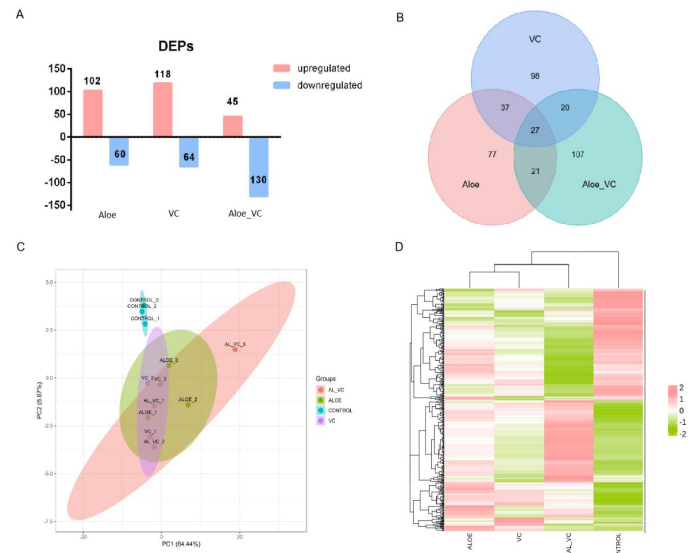


Fig. 2. Differentially expressed proteins (DEPs) of muscle samples between the treatment groups and the control.

Methods

- A total of 240 fish were allocated to one control group and three treatment groups, each receiving a diet supplemented with either lyophilized aloe vera gel (Aloe), VC, or a combination of both (Aloe_VC). Over an eight-week period, we assessed collagen content, gene expression, free amino acids composition and LC-MS/MS proteomic profiles.
- The hydroxyproline content in skin and muscle was quantified using the chloramine T method with a commercial kit (HY-60031, Beijing Sino-uk Institute of Biological Technology, Beijing, China). The collagen content was determined by multiplying the hydroxyproline concentration by 8, assuming that collagen in connective tissue comprises 12.5% hydroxyproline (AOAC, 2000).
- Liquid chromatography was conducted using an EASY-nLCTM 1200UHPLC system, coupled with a Q ExactiveTM mass spectrometer in data-dependent acquisition mode. The top 40 most abundant precursors were selected for fragmentation and analyzed via MS/MS. Significant differentially expressed proteins (DEPs) were identified at a significance level of $p < 0.05$, with a fold change > 1.2 or < 0.83 . The Gene Ontology (GO) Terms was used for protein annotation by Goseq (Young et al., 2010). The databases of kyoto encyclopedia of genes and genomes (KEGG) were utilized for pathway analysis (Mao et al., 2005).

Conclusion

In conclusion, aloe vera gel and VC have demonstrated substantial effects in promoting collagen synthesis in fish

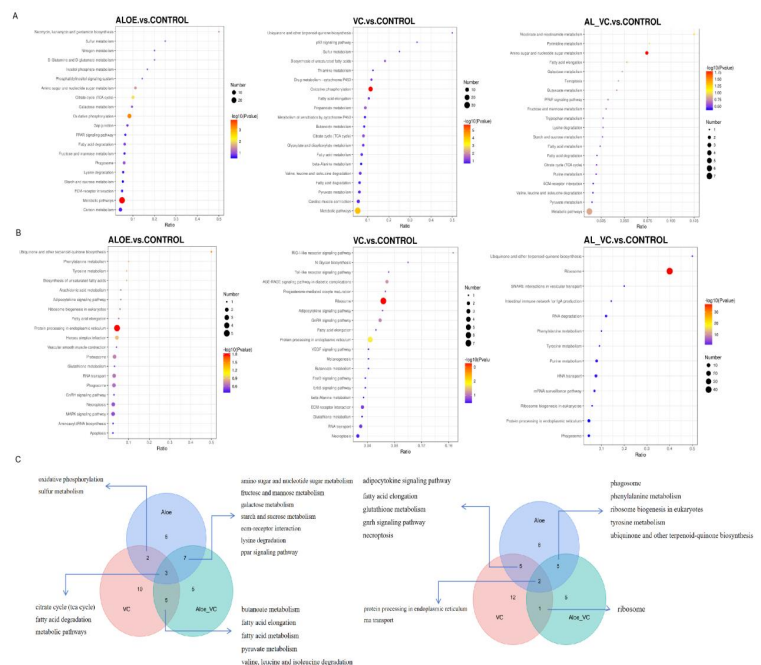


Fig. 3. KEGG pathway enrichment for (A) up-regulated proteins (B) down-regulated proteins between the treatment group and the control group..