

## Supplementary Methods

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### Effect of carnosine or $\beta$ -alanine supplementation on glycemic control and insulin resistance in humans and animals: a systematic review and meta-analysis

Joseph J Matthews, Eimear Dolan, Paul A Swinton, Livia Santos, Guilherme G Artioli, Mark D Turner, Kirsty J Elliott-Sale, Craig Sale

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### Contents

1. Full search strings for each database
2. Completed PRESS checklist
3. Excluded full text papers with reasons for exclusion

## Supplemental methods 1: full search strings for each database

PubMed search strategy – <https://pubmed.ncbi.nlm.nih.gov/>

### Search builder

- |  |   |
|--|---|
| 1. “glucose metabolism disorders” [MeSH Terms] | 14. “insulin” [MeSH Terms]                |
| 2. “metabolic syndrome” [MeSH Terms]           | 15. “insulin” [All Fields]                |
| 3. “diabetes” [All Fields]                     | 16. “blood glucose” [MeSH Terms]          |
| 4. “prediabetes” [All Fields]                  | 17. “fasting glucose” [All Fields]        |
| 5. “hyperglycemia” [All Fields]                | 18. “blood glucose” [All Fields]          |
| 6. “hyperglycaemia” [All Fields]               | 19. “plasma glucose” [All Fields]         |
| 7. “overweight” [MeSH Terms]                   | 20. “glycemic” [All Fields]               |
| 8. “overweight” [All Fields]                   | 21. “glycaemic” [All Fields]              |
| 9. “obesity” [All Fields]                      | 22. “glycated hemoglobin A” [MeSH Terms]  |
| 10. or/1-9                                     | 23. “glycated haemoglobin A” [All Fields] |
| 11. “carnosine” [Title/Abstract]               | 24. “HbA1c” [All Fields]                  |
| 12. “beta-alanine” [Title/Abstract]            | 25. or/14-24                              |
| 13. or/11-12                                   | 26. and/10, 13, 25                        |

Filters or Limiters: None applied.

Date Conducted: December 31, 2020. Papers retrieved, n = 80.

Overview	
Full Search	((“glucose metabolism disorders” [MeSH Terms] OR “metabolic syndrome” [MeSH Terms] OR “diabetes” [All Fields] OR “prediabetes” [All Fields] OR “hyperglycemia” [All Fields] OR “hyperglycaemia” [All Fields] OR “overweight” [MeSH Terms] OR “overweight” [All Fields] OR “obesity” [All Fields]) AND (“carnosine” OR “beta-alanine” [Title/Abstract])) AND (“insulin” [MeSH Terms] OR “insulin” [All Fields] OR “blood glucose” [MeSH Terms] OR “fasting glucose” [All Fields] OR “blood glucose” [All Fields] OR “plasma glucose” [All Fields] OR “glycemic” [All Fields] OR “glycaemic” [All Fields] OR “glycated hemoglobin A” [MeSH Terms] OR “glycated haemoglobin A” [All Fields] OR “HbA1c” [All Fields])
Breakdown	
Population	“glucose metabolism disorders” [MeSH Terms] OR “metabolic syndrome” [MeSH Terms] OR “diabetes” [All Fields] OR “prediabetes” [All Fields] OR “hyperglycemia” [All Fields] OR “hyperglycaemia” [All Fields] OR “overweight” [MeSH Terms] OR “overweight” [All Fields] OR “obesity” [All Fields]
Intervention	“carnosine” OR “beta-alanine” [Title/Abstract]
Outcome	“insulin” [MeSH Terms] OR “insulin” [All Fields] OR “blood glucose” [MeSH Terms] OR “fasting glucose” [All Fields] OR “blood glucose” [All Fields] OR “plasma glucose” [All Fields] OR “glycemic” [All Fields] OR “glycaemic” [All Fields] OR “glycated hemoglobin A” [MeSH Terms] OR “glycated haemoglobin A” [All Fields] OR “HbA1c” [All Fields]

## Scopus search strategy – <https://www.scopus.com/>

### Search builder

1. “Metabolic syndrome” [ALL]
2. “Diabetes” [ALL]
3. “Prediabetes” [ALL]
4. “Hyperglycemia” [ALL]
5. “Hyperglycaemia” [ALL]
6. “Overweight” [ALL]
7. “Obesity” [ALL]
8. or/1-7
9. “Carnosine” [TITLE-ABS-KEY]
10. “Beta-alanine” [TITLE-ABS-KEY]
11. or/9-10
12. “Insulin” [ALL]
13. “Fasting glucose” [ALL]
14. “Blood glucose” [ALL]
15. “Plasma glucose” [ALL]
16. “Glycemic” [ALL]
17. “Glycaemic” [ALL]
18. “Glycated hemoglobin A” [ALL]
19. “Glycated haemoglobin A” [ALL]
20. “HbA1c” [ALL]
21. or/12-20
22. and/8, 11, 21

TITLE-ABS-KEY = Title, Abstract and Keywords, ALL = All Fields.

Filters or Limiters: Document type “Article”.

Date Conducted: December 31, 2020. Papers retrieved, n = 452.

Overview	
Full Search	(ALL("diabetes" OR "prediabetes" OR "hyperglycemia" OR "hyperglycaemia" OR "metabolic syndrome" OR "overweight" OR "obesity") AND TITLE-ABS-KEY("carnosine" OR "beta-alanine")AND ALL("insulin" OR "fasting glucose" OR "blood glucose" OR "plasma glucose" OR "glycemic" OR "glycaemic" OR "glycated haemoglobin A" OR "glycated hemoglobin A" OR "HbA1c")) AND ( LIMIT-TO ( DOCTYPE,"ar" ) )
Breakdown	
Population	“diabetes” [ALL] OR “prediabetes” [ALL] OR “hyperglycemia” [ALL] OR “hyperglycaemia” [ALL] OR “metabolic syndrome” [ALL] OR “overweight” [ALL] OR “obesity” [ALL]
Intervention	"carnosine" [TITLE-ABS-KEY] OR "beta-alanine" [TITLE-ABS-KEY]
Outcome	“insulin” [ALL] OR “fasting glucose” [ALL] OR “blood glucose” [ALL] OR “plasma glucose” [ALL] OR “glycemic” [ALL] OR “glycaemic” [ALL] OR “glycated hemoglobin A” [ALL] OR “glycated haemoglobin A” [ALL] OR “HbA1c” [ALL]

**Web of Science search strategy – <https://www.webofknowledge.com/>**

### Search builder

1. TS="carnosine" OR "beta-alanine"
2. TS="carnosine" OR "beta-alanine"
3. TS="carnosine" OR "beta-alanine"
4. or/1-3
5. TS="metabolic syndrome"
6. TS="diabetes"
7. TS="prediabetes"
8. TS="hyperglycemia"
9. TS="hyperglycaemia"
10. TS="overweight"
11. TS="obesity"
12. or/5-11
13. TS="insulin"
14. TS="fasting glucose"
15. TS="blood glucose"
16. TS="plasma glucose"
17. TS="glycemic"
18. TS="glycaemic"
19. TS="glycated hemoglobin A"
20. TS="glycated haemoglobin A"
21. TS="HbA1c"
22. or/13-21
23. and/4, 12, 22

TI = Title, AB = Abstract, AK = Author Keywords, TS = Topic.

Filters or Limiters: None applied.

Date Conducted: December 31, 2020. Papers retrieved, n = 179

Overview	
Full Search	TS=("carnosine" OR "beta-alanine") AND TS=("diabetes" OR "prediabetes" OR "hyperglycemia" OR "hyperglycaemia" OR "metabolic syndrome" OR "overweight" OR "obesity") AND TS=("insulin" OR "fasting glucose" OR "blood glucose" OR "plasma glucose" OR "glycemic" OR "glycaemic" OR "glycated haemoglobin A" OR "glycated hemoglobin A" OR "HbA1c")
Breakdown	
Population	TS=("diabetes" OR "prediabetes" OR "hyperglycemia" OR "hyperglycaemia" OR "metabolic syndrome" OR "overweight" OR "obesity")
Intervention	TS=("carnosine" OR "beta-alanine")
Outcome	TS=("insulin" OR "fasting glucose" OR "blood glucose" OR "plasma glucose" OR "glycemic" OR "glycaemic" OR "glycated hemoglobin A" OR "glycated haemoglobin A" OR "HbA1c")

## CENTRAL search strategy – <https://www.cochranelibrary.com/central>

### Search builder

1. “metabolic syndrome” [All Text]
2. “diabetes” [All Text]
3. “prediabetes” [All Text]
4. “hyperglycemia” [All Text]
5. “hyperglycaemia” [All Text]
6. “overweight” [All Text]
7. “obesity” [All Text]
8. or/1-7
9. “carnosine” [ti,ab,kw]
10. “beta-alanine” [ti,ab,kw]
11. or/9-10
12. “insulin” [All Text]
13. “fasting glucose” [All Text]
14. “blood glucose” [All Text]
15. “plasma glucose” [All Text]
16. “glycemic” [All Text]
17. “glycaemic” [All Text]
18. “glycated hemoglobin A” [All Text]
19. “glycated haemoglobin A” [All Text]
20. “HbA1c” [All Text]
21. or/12-20
22. and/8, 11, 21

ti = Title, ab = Abstract, kw = Keywords.

Filters or Limiters: “Trials” only.

Date Conducted: December 31, 2020. Papers retrieved, n = 36.

Overview	
Full Search	(“diabetes” OR “prediabetes” OR “hyperglycemia” OR “hyperglycaemia” OR “metabolic syndrome” OR “overweight” OR “obesity”) AND (“carnosine” OR “beta-alanine”):ti,ab,kw AND (“insulin” OR “fasting glucose” OR “blood glucose” OR “plasma glucose” OR “glycemic” OR “glycaemic” OR “glycated hemoglobin A” OR “glycated haemoglobin A” OR “HbA1c”)
Breakdown	
Population	“diabetes” OR “prediabetes” OR “hyperglycemia” OR “hyperglycaemia” OR “metabolic syndrome” OR “overweight” OR “obesity”
Intervention	“carnosine” OR “beta-alanine”:ti,ab,kw
Outcome	“insulin” OR “fasting glucose” OR “blood glucose” OR “plasma glucose” OR “glycemic” OR “glycaemic” OR “glycated hemoglobin A” OR “glycated haemoglobin A” OR “HbA1c”

**ProQuest search strategy – <https://search.proquest.com/advanced>**

**Search builder**

1. “metabolic syndrome” [All Text]
2. “diabetes” [All Text]
3. “prediabetes” [All Text]
4. “hyperglycemia” [All Text]
5. “hyperglycaemia” [All Text]
6. “overweight” [All Text]
7. “obesity” [All Text]
8. or/1-7
9. “carnosine” [ab]
10. “beta-alanine” [ab]
11. or/9-10
12. “insulin” [All Text]
13. “fasting glucose” [All Text]
14. “blood glucose” [All Text]
15. “plasma glucose” [All Text]
16. “glycemic” [All Text]
17. “glycaemic” [All Text]
18. “glycated hemoglobin A” [All Text]
19. “glycated haemoglobin A” [All Text]
20. “HbA1c” [All Text]
21. or/12-20
22. and/8, 11, 21

ab = Abstract.

Filters or Limiters: None applied.

Date Conducted: December 31, 2020. Papers retrieved, n = 200.

Overview	
Full Search	("diabetes" OR "prediabetes" OR "hyperglycemia" OR "hyperglycaemia" OR "metabolic syndrome" OR "overweight" OR "obesity") AND ab ("carnosine" OR "beta-alanine") AND ("insulin" OR "fasting glucose" OR "blood glucose" OR "plasma glucose" OR "glycemic" OR "glycaemic" OR "glycated hemoglobin A" OR "glycated haemoglobin A" OR "HbA1c")
Breakdown	
Population	(“diabetes” OR “prediabetes” OR “hyperglycemia” OR “hyperglycaemia” OR “metabolic syndrome” OR “overweight” OR “obesity”)
Intervention	ab(“carnosine” OR “beta-alanine”)
Outcome	(“insulin” OR “fasting glucose” OR “blood glucose” OR “plasma glucose” OR “glycemic” OR “glycaemic” OR “glycated hemoglobin A” OR “glycated haemoglobin A” OR “HbA1c”)

**CINAHL Complete search strategy** – <https://health.ebsco.com/products/cinahl-complete/allied-health-nursing>

**Search builder**

1. “metabolic syndrome” [TX]
2. “diabetes” [TX]
3. “prediabetes” [TX]
4. “hyperglycemia” [TX]
5. “hyperglycaemia” [TX]
6. “overweight” [TX]
7. “obesity” [TX]
8. or/1-7
9. “carnosine” [TX]
10. “beta-alanine” [TX]
11. or/9-10
12. “insulin” [TX]
13. “fasting glucose” [TX]
14. “blood glucose” [TX]
15. “plasma glucose” [TX]
16. “glycemic” [TX]
17. “glycaemic” [TX]
18. “glycated hemoglobin A” [TX]
19. “glycated haemoglobin A” [TX]
20. “HbA1c” [TX]
21. or/12-20
22. and/8, 11, 21

AB = Abstract, TX = All Text.

Filters or Limiters: None applied.

Date Conducted: December 31, 2020. Papers retrieved, n = 19.

<b>Overview</b>	
Full Search	TX ( “diabetes” OR “prediabetes” OR “hyperglycemia” OR “hyperglycaemia” OR “metabolic syndrome” OR “overweight” OR “obesity” ) AND AB ( “carnosine” OR “beta-alanine” ) AND TX ( “insulin” OR “fasting glucose” OR “blood glucose” OR “plasma glucose” OR “glycemic” OR “glycaemic” OR “glycated hemoglobin A” OR “glycated haemoglobin A” OR “HbA1c” )
<b>Breakdown</b>	
Population	TX ( “diabetes” OR “prediabetes” OR “hyperglycemia” OR “hyperglycaemia” OR “metabolic syndrome” OR “overweight” OR “obesity” )
Intervention	AB ( “carnosine” OR “beta-alanine” )
Outcome	TX ( “insulin” OR “fasting glucose” OR “blood glucose” OR “plasma glucose” OR “glycemic” OR “glycaemic” OR “glycated hemoglobin A” OR “glycated haemoglobin A” OR “HbA1c” )

## Supplemental methods 2: completed PRESS checklist

### *PRESS Guideline* — search submission & peer review assessment

**Search submission:** this section to be filled in by the searcher

**Searcher:** Joseph J Matthews

**E-mail:** [joseph.matthews2016@my.ntu.ac.uk](mailto:joseph.matthews2016@my.ntu.ac.uk)

**Date submitted:** 17/06/2020

**Date requested by:** 24/06/2020

**Systematic review title:** The effect of carnosine or  $\beta$ -alanine supplementation on markers of glycaemic control and insulin resistance in human and animal studies: a protocol for a systematic review and meta-analysis

This search strategy is ...

<b>X</b>	My PRIMARY (core) database strategy — First time submitting a strategy for search question and database
	My PRIMARY (core) strategy — Follow-up review NOT the first time submitting a strategy for search question and database. If this is a response to peer review, itemize the changes made to the review suggestions
	SECONDARY search strategy— First time submitting a strategy for search question and database
	SECONDARY search strategy — NOT the first time submitting a strategy for search question and database. If this is a response to peer review, itemize the changes made to the review suggestions

### Database

PubMed (<https://pubmed.ncbi.nlm.nih.gov/>)

### Interface

PubMed (<https://pubmed.ncbi.nlm.nih.gov/>)

### Research question

The purpose of this systematic review and meta-analysis is to evaluate the effect of carnosine or  $\beta$ -alanine supplementation on markers of glycaemic control and insulin resistance in humans and animals.



## Overview of PICOS eligibility criteria.

Participants	<p>Humans with type I diabetes, type II diabetes, prediabetes, gestational diabetes, impaired fasting glucose, or impaired glucose tolerance (according to WHO guidelines: WHO, 2006; 2011); or with overweight/obesity (BMI <math>\geq 25</math> kg.m<sup>2</sup>) where the relevant outcomes were collected and reported.</p> <p>Animal studies using a diabetes-related disease model (see human criteria above); or overweight/obese animals where the relevant outcomes were collected and reported.</p> <p>No restriction on age or comorbidities; or on the methods used to induce disease in animal studies.</p>
Intervention	<p>Supplementation with carnosine or <math>\beta</math>-alanine. We excluded studies that used a multi-ingredient supplement intervention.</p> <p>Human studies included oral administration only, whereas animal studies also included administration by other means (<i>e.g.</i>, intraperitoneal or intravenous injection).</p>
Comparator	<p>Comparisons for human studies were between placebo and the experimental intervention.</p> <p>Comparisons for animal studies were between placebo or control (no intervention) and the experimental intervention.</p> <p>We excluded studies without a control or placebo group.</p>
Outcomes	<p>Outcomes relating to glycaemic control and insulin resistance: fasting glucose, HbA<sub>1c</sub>, 2-hour glucose following a GTT (see supplementary information for a full list).</p>
Study Designs	<p>Studies were limited to non-randomised and RCTs, including cluster RCTs. We excluded cohort studies, cross-sectional studies, case series, case reports, commentary, and review articles.</p>

BMI, body mass index; GGT, glucose tolerance test; RCTs, randomised controlled trials; WHO, World Health Organization.

### Was a search filter applied?

Yes

No



Please copy and paste your search strategy here, exactly as run, including the number of hits per line. **Hits per line listed in the box below.**

## Preliminary PubMed search strategy

### Search builder

- |   |   |
|---|---|
| 14. "glucose metabolism disorders" [MeSH Terms] | 27. "insulin" [MeSH Terms]                |
| 15. "metabolic syndrome" [MeSH Terms]           | 28. "insulin" [All Fields]                |
| 16. "diabetes" [All Fields]                     | 29. "blood glucose" [MeSH Terms]          |
| 17. "prediabetes" [All Fields]                  | 30. "fasting glucose" [All Fields]        |
| 18. "hyperglycemia" [All Fields]                | 31. "blood glucose" [All Fields]          |
| 19. "hyperglycaemia" [All Fields]               | 32. "plasma glucose" [All Fields]         |
| 20. "overweight" [MeSH Terms]                   | 33. "glycemic" [All Fields]               |
| 21. "overweight" [All Fields]                   | 34. "glycaemic" [All Fields]              |
| 22. "obesity" [All Fields]                      | 35. "glycated hemoglobin A" [MeSH Terms]  |
| 23. or/1-9                                      | 36. "glycated haemoglobin A" [All Fields] |
| 24. "carnosine" [Title/Abstract]                | 37. "HbA1c" [All Fields]                  |
| 25. "beta-alanine" [Title/Abstract]             | 38. or/14-24                              |
| 26. or/11-12                                    | 39. and/10, 13, 25                        |

Filters or Limiters: None applied.

Date Conducted: June 24, 2020.

Overview	
Full Search (hits: n=73)	((("glucose metabolism disorders" [MeSH Terms] OR "metabolic syndrome" [MeSH Terms] OR "diabetes" [All Fields] OR "prediabetes" [All Fields] OR "hyperglycemia" [All Fields] OR "hyperglycaemia" [All Fields] OR "overweight" [MeSH Terms] OR "overweight" [All Fields] OR "obesity" [All Fields]) AND ("carnosine" OR "beta-alanine"[Title/Abstract])) AND ("insulin" [MeSH Terms] OR "insulin" [All Fields] OR "blood glucose" [MeSH Terms] OR "fasting glucose" [All Fields] OR "blood glucose" [All Fields] OR "plasma glucose" [All Fields] OR "glycemic" [All Fields] OR "glycaemic" [All Fields] OR "glycated hemoglobin A" [MeSH Terms] OR "glycated haemoglobin A" [All Fields] OR "HbA1c" [All Fields]))
Breakdown	
Population (hits: n=1,005,522)	"glucose metabolism disorders" [MeSH Terms] OR "metabolic syndrome" [MeSH Terms] OR "diabetes" [All Fields] OR "prediabetes" [All Fields] OR "hyperglycemia" [All Fields] OR "hyperglycaemia" [All Fields] OR "overweight" [MeSH Terms] OR "overweight" [All Fields] OR "obesity" [All Fields]
Intervention (hits: n=5,518)	"carnosine" OR "beta-alanine"[Title/Abstract]
Outcome (hits: n=549,941)	"insulin" [MeSH Terms] OR "insulin" [All Fields] OR "blood glucose" [MeSH Terms] OR "fasting glucose" [All Fields] OR "blood glucose" [All Fields] OR "plasma glucose" [All Fields] OR "glycemic" [All Fields] OR "glycaemic" [All Fields] OR "glycated hemoglobin A" [MeSH Terms] OR "glycated haemoglobin A" [All Fields] OR "HbA1c" [All Fields]

**PEER REVIEW ASSESSMENT: THIS SECTION TO BE FILLED IN BY THE REVIEWER**

Reviewer:  
Victoria Boskett  
Research Support  
Librarian

Email:  
[victoria.boskett@ntu.ac.uk](mailto:victoria.boskett@ntu.ac.uk)

Date completed:  
24/06/2020

**1. TRANSLATION**

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s) suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

If “B” or “C,” please provide an explanation or example:

**2. BOOLEAN AND PROXIMITY OPERATORS**

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s) suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

If “B” or “C,” please provide an explanation or example:

**3. SUBJECT HEADINGS**

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s) suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

If “B” or “C,” please provide an explanation or example:

**4. TEXT WORD SEARCHING**

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s) suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

If “B” or “C,” please provide an explanation or example:

## 5. SPELLING, SYNTAX, AND LINE NUMBERS

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s)suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

If “B” or “C,” please provide an explanation or example:

## 6. LIMITS AND FILTERS

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s) suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

If “B” or “C,” please provide an explanation or example:

## 7. OVERALL EVALUATION (Note: If one or more “revision required” is noted above, the response below must be “revisions required”.)

A ---No revisions	<input checked="" type="checkbox"/>
B --- Revision(s) suggested	<input type="checkbox"/>
C --- Revision(s) required	<input type="checkbox"/>

Additional comments:

### Supplementary methods 3: excluded full text papers with reasons for exclusion

The exclusion code for each article is provided prior to the first author's name.

- [1] Inappropriate population (n=4)**
  - [2] Inappropriate intervention (n=4)**
  - [3] Inappropriate comparator (n=1)**
  - [4] Inappropriate outcome (n=15)**
  - [5] Inappropriate study design (n=1)**
  - [6] Multiple inappropriate criteria (n=4)**
  - [7] Could not obtain necessary data (n=1)**
  - [8] Duplicate data set to another included study (n=9)**
- 
- [4] Ahshin-Majd S, Zamani S, Kiamari T, Kiasalari Z, Baluchnejadmojarad T, Roghani M. Carnosine ameliorates cognitive deficits in streptozotocin-induced diabetic rats: Possible involved mechanisms. *Peptides*. 2016;86:102-11.
  - [1] Anderson EJ, Vistoli G, Katunga LA, Funai K, Regazzoni L, Monroe TB, Gilardoni E, Cannizzaro L, Colzani M, De Maddis D, Rossoni G. A carnosine analog mitigates metabolic disorders of obesity by reducing carbonyl stress. *The Journal of clinical investigation*. 2018;128(12):5280-93.
  - [4] Ansurudeen I, Sunkari VG, Grünler J, Peters V, Schmitt CP, Catrina SB, Brismar K, Forsberg EA. Carnosine enhances diabetic wound healing in the db/db mouse model of type 2 diabetes. *Amino acids*. 2012;43(1):127-34.
  - [8] Aydın AF, Küçükgergin C, Bingül İ, Doğan-Ekici I, Doğru-Abbasoğlu S, Uysal M. Effect of carnosine on renal function, oxidation and glycation products in the kidneys of high-fat diet/streptozotocin-induced diabetic rats. *Experimental and Clinical Endocrinology & Diabetes*. 2017;125(05):282-9.
  - [8] Baye E, Ukropec J, de Courten MP, Kurdiova T, Krumpolec P, Fernández-Real JM, Aldini G, Ukropcova B, de Courten B. Carnosine supplementation reduces plasma soluble transferrin receptor in healthy overweight or obese individuals: a pilot randomised trial. *Amino acids*. 2019;51(1):73-81.
  - [8] Baye E, Ukropec J, De Courten MP, Mousa A, Kurdiova T, Johnson J, Wilson K, Plebanski M, Aldini G, Ukropcova B, De Courten B. Carnosine supplementation improves serum resistin concentrations in overweight or obese otherwise healthy adults: a pilot randomized trial. *Nutrients*. 2018;10(9):1258.
  - [8] Baye E, Ukropec J, De Courten MP, Vallova S, Krumpolec P, Kurdiova T, Aldini G, Ukropcova B, De Courten B. Effect of carnosine supplementation on the plasma lipidome in overweight and obese adults: a pilot randomised controlled trial. *Scientific reports*. 2017;7(1):1-7.
  - [7] Brown BE, Kim CH, Torpy FR, Bursill CA, McRobb LS, Heather AK, Davies MJ, Van Reyk DM. Supplementation with carnosine decreases plasma triglycerides and modulates atherosclerotic plaque composition in diabetic apo E<sup>-/-</sup> mice. *Atherosclerosis*. 2014;232(2):403-9.
  - [8] Chang KJ. Effect of taurine and  $\beta$ -alanine on morphological changes of pancreas in streptozotocin-induced rats. In: Della Corte L, Huxtable RJ, Sgaragli G, Tipton KF (Eds.). *Taurine 4: Taurine and Excitable Tissues* (vol. 483). 2002 (pp. 571-577). Springer, Boston, MA.

- [1] Chang KJ, Kwon W. Immunohistochemical localization of insulin in pancreatic  $\beta$ -Cells of taurine-supplemented or taurine-depleted diabetic rats. In: Della Corte L, Huxtable RJ, Sgaragli G, Tipton KF (Eds.). *Taurine 4: Taurine and Excitable Tissues* (vol. 483). 2002 (pp. 579-587). Springer, Boston, MA.
- [4] Forsberg EA, Botusan IR, Wang J, Peters V, Ansurudeen I, Brismar K, Catrina SB. Carnosine decreases IGFBP1 production in db/db mice through suppression of HIF-1. *J Endocrinol.* 2015;225(3):159-67.
- [4] Guo Y, Guo C, Ha W, Ding Z. Carnosine improves diabetic retinopathy via the MAPK/ERK pathway. *Experimental and therapeutic medicine.* 2019;17(4):2641-7.
- [6] Han CH, Lin YS, Lee TL, Liang HJ, Hou WC. Asn-Trp dipeptides improve the oxidative stress and learning dysfunctions in D-galactose-induced BALB/c mice. *Food & function.* 2014;5(9):2228-36.
- [8] Houjehani S, Kheirouri S, Faraji E, Asghari Jafarabadi M, Jabbari M. Antioxidant Status, Lipid Peroxidation and Protein Oxidation in Type 2 Diabetic Patients; Beneficial Effects of Supplementation with Carnosine: A Randomized, Double-Blind, Placebo-Controlled Trial. *Iranian Red Crescent Medical Journal.* 2018;20(3).
- [4] Korolkiewicz RP, Fujita A, Seto K, Suzuki K, Takeuchi K. Polaprezinc exerts a salutary effect on impaired healing of acute gastric lesions in diabetic rats. *Digestive diseases and sciences.* 2000;45(6):1200-9.
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