UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

TOM SABATANO, individually and on behalf of all others similarly situated, Plaintiffs, v. IOVATE HEALTH SCIENCES U.S.A. INC. A/K/A MUSCLETECH, Defendant.	Civil Action No. **CLASS ACTION COMPLAINT** **JURY TRIAL DEMANDED**

Plaintiff Tom Sabatano ("Plaintiff") brings this action on behalf of himself and all others similarly situated against Defendant Iovate Health Sciences U.S.A. Inc. a/k/a Muscletech ("Defendant" or "Iovate"). Plaintiff makes the following allegations pursuant to the investigation of his counsel and based upon information and belief, except as to the allegations specifically pertaining to himself, which are based on personal knowledge.

NATURE OF THE ACTION

1. This is a class action lawsuit against Iovate for selling a defective dietary supplement product, Platinum 100% BCAA[1] 8:1:1 ("Platinum BCAA" or the "Product"), through its Muscletech brand which purports to "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," and provide the user with the "key building blocks of muscle." But actually, based on independent, peer-reviewed research, BCAA supplements decrease muscle protein synthesis and are wholly incapable of building muscle on their own. Dr. Robert Wolfe, a renowned and highly-respected authority in the area of amino

[1] The acronym "BCAA" stands for "branched-chain amino acids."

acid metabolism, concludes that consumption of BCAA supplements actually **negatively impacts** muscle protein synthesis due to lack of all essential amino acids ("EAA"), which causes EAAs stored in the muscle to be catabolized, thereby perpetuating a catabolic state of muscle protein breakdown. To build muscle, the body must have an abundant availability of all EAAs, which must be consumed through the diet. Anything less than a full panel of EAAs will grind any increase in muscle protein synthesis to a halt due to lack of sufficient raw materials with which the body can use to build muscle mass. Platinum BCAA contains only three of the nine EAAs, and therefore it cannot, in fact, build muscle. As such, Iovate's claims that the Product "Promotes Muscle Protein Synthesis," "ensures that your muscles are primed for musclebuilding," and provides "key building blocks of muscle" are false and misleading based on peer-reviewed scientific data. In fact, the Product negatively impacts protein synthesis, thereby leaving Plaintiff and Class members (defined below) in a **worse position than if not taking the product at all**. Plaintiff brings this class action lawsuit on behalf of himself and purchasers of the Platinum BCAA dietary supplement.

A. Overview of Amino Acids

2. Amino acids are known as "building blocks" for protein, in that protein is made up of a sequence of amino acids held together by peptide bonds.[2]

3. A total of twenty amino acids comprise muscle protein.[3] They are classified as either essential, non-essential, or conditionally essential. Nine of the twenty are known as "essential amino acids" (EAA) because "they cannot be produced by the body in physiologically

[2] https://medlineplus.gov/ency/article/002222.htm (last visited 8/28/19)
[3] Robert R. Wolfe, *Branched-chain Amino Acids And Muscle Protein Synthesis In Humans: Myth Or Reality?* (J. Int'l Society of Sports Nutrition Aug. 22, 2017), at 1 (attached hereto as **Exhibit A)**.

significant amounts, and therefore are crucial components of a balanced diet."[4] Non-essential amino acids are those produced in the body and therefore are not required to be consumed in the diet.[5] Conditionally-essential amino acids are those which are usually non-essential except in certain circumstances, such as illness.[6]

Essential	Conditionally Non-Essential	Non-Essential
Histidine	Arginine	Alanine
Isoleucine	Cystine	Asparagine
Leucine	Glutamine	Aspartate
Lysine	Glycine	Glutamate
Methionine	Proline	Serine
Phenylalanine	Tyrosine	
Threonine		
Tryptophan		
Valine		

4. Three of the nine essential amino acids are known as branched-chain amino acids ("BCAAs"), which are leucine, valine, and isoleucine.[7] They are called "branched-chain amino acids" because of their branched molecular structure.

B. <u>Role of Amino Acids in Muscle Building</u>

5. "Muscle protein is in a constant state of turnover, meaning that protein synthesis is occurring continuously to replace protein lost as a consequence of protein breakdown."[8]

6. The "anabolic state," or muscle growth, occurs when the rate of muscle protein synthesis is greater than the rate of protein breakdown.[9]

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[4] *Id.*
[5] https://medlineplus.gov/ency/article/002222.htm (last visited 8/28/19)
[6] *Id.*
[7] Ex. A, at 1.
[8] *Id.* at 1-2.

7. For muscle building to occur by way of stimulation of muscle protein synthesis, there must be an "abundant availability of all EAAs."[10] This is because muscle cannot be built without the necessary raw materials, to wit all EAAs.

8. For this reason, protein sources containing adequate amounts of all nine essential amino acids are known as "complete proteins."[11]

9. BCAAs, however, are not "complete proteins" because they are comprised of only three of the nine essential amino acids. As such, a nutritional supplement containing only BCAAs cannot build muscle, because there is not an "abundant availability of all EAAs" required to build muscle. In short, "[m]uscle protein synthesis will be limited by the lack of availability of any of the EAAs. . . ."[12]

10. When insufficient EAAs are consumed, the only potential source for EAAs for muscle protein synthesis are those derived from muscle protein breakdown, and therefore "it is impossible for muscle protein synthesis to exceed the rate of muscle protein breakdown when the precursors are derived entirely from protein breakdown, and thus an anabolic state cannot occur in the absence of exogenous amino acid intake."[13]

(...footnote continued)

[9] *Id.* at 3.

[10] *Id.*

[11] https://www.accessdata.fda.gov/scripts/InteractiveNutritionFactsLabel/protein.html (last visited 8/28/19)

[12] Ex. A, at 3.

[13] *Id.*

C. Platinum BCAA Does Not Build Muscle Via Enhanced Muscle Protein Synthesis

11. "The sale of BCAAs as nutritional supplements has become a multi-million dollar business."[14] "At the center of the marketing for these products is the widely-believed claim that consumption of BCAAs stimulates muscle protein synthesis, and as a result elicits an anabolic response."[15] However, recent peer-reviewed research has determined that these marketing claims are false and misleading.

1. Dr. Robert Wolfe's Peer-Reviewed Study Finds BCAA Supplements Do Not Build Muscle And Actually Decrease Muscle Protein Synthesis

12. Dr. Robert Wolfe is a highly-regarded researcher in his field. He has published 452 peer-reviewed research articles, 126 review articles, and three books. His papers have been cited 50,663 times.[16] Dr. Wolfe has performed extensive research in the field of muscle metabolism.

13. In August of 2017, Dr. Wolfe published a peer-reviewed study in the Journal of the International Society of Sports Nutrition entitled *Branched-chain amino acids and muscle protein synthesis in humans: myth or reality?* Dr. Wolfe performed a review of both the theoretical considerations and empirical research relating to BCAAs, and concluded that "the claim that consumption of dietary BCAAs stimulates muscle protein synthesis or produces an anabolic response in human subjects is unwarranted."[17]

14. As to the theoretical considerations, Dr. Wolfe explained that in order for the body to reach an anabolic state (i.e. where the rate of muscle protein synthesis exceeds the rate of

[14] *Id.* at 2.
[15] *Id.*
[16] *See* http://aging.uams.edu/dr-robert-r-wolfe/ (last visited 8/28/19)
[17] Ex. A, at 1.

muscle protein breakdown), there must be an abundance of all nine EAAs, not just the three BCAAs.[18] "Muscle protein synthesis will be limited by the lack of availability of any of the EAAs, whereas a shortage of [non-essential amino acids] can be compensated for by increased de novo production of the deficient [non-essential amino acids]."[19]

15. When less than a full panel of EAAs are ingested (such as when ingesting a BCAA supplement), the only source of EAA precursors for muscle protein synthesis are those derived from muscle breakdown, which means that muscle is being broken down to provide EAAs for protein synthesis, rendering it impossible for the body to reach an anabolic state. Dr. Wolfe explains that "it is impossible for muscle protein synthesis to exceed the rate of muscle protein breakdown when the precursors are derived entirely from protein breakdown, and thus an anabolic state cannot occur in the absence of exogenous amino acid intake."[20]

16. Dr. Wolfe then reviewed the empirical evidence from human studies involving the effects of BCAA consumption, which revealed that "BCAA infusion **not only fails to increase the rate of muscle protein synthesis in human subjects, but actually reduces the rate of muscle protein synthesis** and the rate of muscle protein turnover."[21]

17. Dr. Wolfe concluded:

> When all evidence and theory is considered together, it is reasonable to conclude that there is no credible evidence that ingestion of a dietary supplement of BCAAs alone results in a physiologically significant stimulation of muscle protein. **In fact, available evidence indicates that BCAAs actually decrease muscle protein synthesis.** All EAAs must be available in abundance for increased anabolic signaling to translate to accelerated muscle protein synthesis.[22]

[18] *Id.* at 3.
[19] *Id.*
[20] *Id.*
[21] *Id.* at 5.
[22] *Id.* at 6.

2. Other Scholars Agree That BCAA Supplements Do Not Build Muscle

18. Researchers at the Gatorade Sports Science Institute reached an identical conclusion to that of Dr. Wolfe regarding the effects of BCAA supplements on muscle protein synthesis. The study concluded that there is "no reason to consume BCAA supplements for enhanced stimulation of [muscle protein synthesis] and/or decreased [muscle protein breakdown]."[23] The researchers further explained:

> The claims for [BCAA] products are based on a wide range of mechanisms: from enhanced muscle protein synthesis (MPS) and decreased muscle protein breakdown (MPB) to protection of the immune system, increased fat oxidation and decreased muscle soreness, among many others. The physiological rationale for these claims, let alone robust evidence from well-controlled human studies, is often weak, if not completely lacking.[24]

19. Dr. Susan Kleiner, a scientist, researcher, and consultant, also concurred with Dr. Wolfe and explained that she does not recommend BCAA supplements, and states that "it may be appropriate to let clients know that BCAA supplementation may decrease their [muscle protein synthesis] and turnover, making them certainly not helpful, and possibly harmful, to their goals."[25]

20. Dr. Jose Antonio, CEO of the International Society of Sports Nutrition noted that "BCAAs should not be marketed as a muscle building supplement . . . ."[26]

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[23] https://www.gssiweb.org/sports-science-exchange/article/branched-chain-amino-acid-supplementation-to-support-muscle-anabolism-following-exercise (last visited 8/28/19).
[24] *Id.*
[25] https://www.nutraingredients-usa.com/Article/2017/08/24/Limited-evidence-backs-BCAA-s-muscle-building-benefits-says-new-study# (last visited 8/28/19).
[26] *Id.*

21. Dr. Stuart Phillips of McMaster University states: "Bottom line: If you're taking in adequate protein [(i.e. a full panel of EAAs)], then BCAAs are a complete waste of money."[27]

3. Iovate's Misrepresentations

22. Despite the findings of Dr. Wolfe and other researchers, Iovate continues to misrepresent that its Platinum BCAA product "Promotes Muscle Protein Synthesis," "ensures that your muscles are primed for musclebuilding," and provides "key building blocks of muscle" (the "Misrepresentations"). Each of the Misrepresentations appear on the product's label.

23. Indeed, the front label panel of Platinum BCAA prominently states "Promotes Muscle Protein Synthesis."

[27] https://www.menshealth.com/nutrition/a19545329/branched-chain-amino-acids/ (last visited 8/28/19).

24. The Platinum BCAA label indicates to the consumer that use of the Product will lead to muscle growth through increased muscle protein synthesis.

25. The label also states that the Product "ensures that your muscles are primed for musclebuilding," and provides "key building blocks of muscle" on the side paneling.

26. But, as discussed above, those label claims are false. According to independent research by Dr. Wolfe, "the claim that consumption of dietary BCAAs stimulates muscle protein synthesis or produces an anabolic response in human subjects is unwarranted."[28] Further, according to Dr. Wolfe, studies in human subjects "**have reported decreases, rather than increases, in muscle protein synthesis after intake of BCAAs**."[29]

27. Plaintiff asserts claims on behalf of himself and a nationwide class and New York subclass of purchasers of Platinum BCAA for violation of New York General Business Law §§ 349 and 350 , violation of the Magnuson-Moss Warranty Act ("MMWA"), 15 U.S.C. §§ 2301, *et seq.*, breach of express warranty, breach of the implied warranty of merchantability, unjust enrichment, and fraud.

THE PARTIES

28. Plaintiff Tom Sabatano is a citizen of New York who resides in Yonkers, New York. In approximately 2018, Mr. Sabatano purchased Iovate's Platinum BCAA product for approximately $30 from a GNC location in Yonkers, New York. At all times, Mr. Sabatano used the product as directed on the label. The Platinum BCAA supplement he purchased prominently displayed on the package the phrase "Promotes Muscle Protein Synthesis." The label also indicated that the Product would "ensure[] that [his] muscles are primed for musclebuilding," and provide "key building blocks of muscle." Mr. Sabatano saw these representations prior to

[28] Ex. A, at 2.
[29] *Id.* At 8.

and at the time of purchase, and understood them as representations and warranties that the product would, in fact, "Promote[] Muscle Protein Synthesis," "ensure[] that [his] muscles are primed for musclebuilding," and provide "key building blocks of muscle." He relied on these representations and warranties in deciding to purchase Iovate's Platinum BCAA product, and these representations and warranties were part of the basis of the bargain in that he would not have purchased Platinum BCAA if he had known that it would not, in fact, "Promote[] Muscle Protein Synthesis," "ensure[] that [his] muscles are primed for musclebuilding," and provide "key building blocks of muscle."

29. Ultimately, Platinum BCAA was worthless (and certainly worth less than its misrepresentations suggested) because it does not, in fact, "Promote[] Muscle Protein Synthesis," "ensure[] that [the user's] muscles are primed for musclebuilding," and does not provide the user with the "key building blocks of muscle." In fact, it actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover. Further, because the Product does not contain all nine EAAs, it cannot build muscle.

30. Defendant Iovate Health Sciences U.S.A. Inc. is a Delaware Corporation with its principal place of business at 1105 North Market Street, Suite 1330, Wilmington, Delaware 19801. Iovate is engaged in the manufacturing, processing, packaging, and distribution of Platinum BCAA. Iovate sells Platinum BCAA throughout New York and the entire United States.

JURISDICTION AND VENUE

31. This Court has subject matter jurisdiction pursuant to 28 U.S.C. § 1332(d)(2)(A) because this case is a class action where the aggregate claims of all members of the proposed class are in excess of $5,000,000.00, exclusive of interest and costs, and Plaintiff, as well as most

members of the proposed class, are citizens of states different from Defendant. This Court also has supplemental jurisdiction over state law claims pursuant to 28 U.S.C. § 1367.

32. Pursuant to 28 U.S.C. § 1391, this Court is the proper venue for this action because Plaintiff is a citizen of New York and resides in this District. Moreover, Defendant distributed, advertised, and sold Platinum BCAA, which is the subject of the present complaint, in this District.

CLASS REPRESENTATION ALLEGATIONS

33. Plaintiff seeks to represent a class defined as all persons in the United States who purchased Iovate's (a/k/a Muscletech's) Platinum BCAA (the "Nationwide Class"). Excluded from the Nationwide Class are persons who made such purchase for purpose of resale, Defendant, Defendant's officers, directors, agents, trustees, parents, children, corporations, trusts, representatives, employees, principals, servants, partners, joint venturers, or entities controlled by Defendant, and their heirs, successors, assigns, or other persons or entities related to or affiliated with Defendant and/or Defendant's officers and/or directors, the judge assigned to this action, and any member of the judge's immediate family.

34. Plaintiff also seeks to represent a subclass of all persons who purchased Iovate's Platinum BCAA in New York (the "New York Subclass").

35. Members of the Nationwide Class and New York Subclass are so numerous that their individual joinder herein is impracticable. Defendant's annual sales of Platinum BCAA are in the millions of dollars; thus, members of the Nationwide Class number in the hundreds of thousands and members of the New York Subclass number in the tens of thousands. The precise number of Class members and their identities are unknown to Plaintiff at this time but may be determined through discovery. Class members may be notified of the pendency of this action by

mail and/or publication through the distribution records of Defendant and third-party retailers and vendors.

36. Common questions of law and fact exist as to all Class members and predominate over questions affecting only individual Class members. Common legal and factual questions include, but are not limited to: whether Platinum BCAA actually "Promotes Muscle Protein Synthesis," "ensures that your muscles are primed for musclebuilding," and provides "key building blocks of muscle."

37. The claims of the named Plaintiff are typical of the claims of the Nationwide Class and New York Subclass in that the named Plaintiff was exposed to and relied on Defendant's false and misleading marketing of Platinum BCAA and suffered a loss as a result of his Platinum BCAA purchase.

38. Plaintiff is an adequate representative of the Nationwide Class and New York Subclass because his interests do not conflict with the interests of the Class members he seeks to represent, he has retained competent counsel experienced in prosecuting consumer class actions, and he intends to prosecute this action vigorously. The interests of the Nationwide Class and New York Subclass members will be fairly and adequately protected by Plaintiff and his counsel.

39. The class mechanism is superior to other available means for the fair and efficient adjudication of the claims of the Nationwide Class and New York Subclass members. Each individual Class member may lack the resources to undergo the burden and expense of individual prosecution of the complex and extensive litigation necessary to establish Defendant's liability. Individualized litigation increases the delay and expense to all parties and multiplies the burden on the judicial system presented by the complex legal and factual issues of this case. Individualized litigation also presents a potential for inconsistent or contradictory judgments. In

contrast, the class action device presents far fewer management difficulties and provides the benefits of single adjudication, economy of scale, and comprehensive supervision by a single court on the issue of Defendant's liability. Class treatment of the liability issues will ensure that all claims and claimants are before this Court for consistent adjudication of the liability issues.

COUNT I
(Deceptive Acts Or Practices, New York Gen. Bus. Law § 349)

40. Plaintiff hereby incorporates by reference the allegations contained in all preceding paragraphs of this complaint.

41. Plaintiff brings this claim individually and on behalf of the members of the proposed New York Subclass against Defendant.

42. By the acts and conduct alleged herein, Defendant committed unfair or deceptive acts and practices by misrepresenting that the Platinum BCAA product would "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," and provide "key building blocks of muscle."

43. The foregoing deceptive acts and practices were directed at consumers.

44. The foregoing deceptive acts and practices are misleading in a material way because they fundamentally misrepresent the characteristics of Platinum BCAA to induce consumers to purchase the same.

45. Plaintiff and members of the New York Subclass were injured because (a) they would not have purchased Platinum BCAA had they known that it would not "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," and provide "key building blocks of muscle," (b) they overpaid for Platinum BCAA products because they are sold at a price premium, and (c) Platinum BCAA products did not have the characteristics, uses, or benefits promised, namely that they do not "Promote[] Muscle Protein

Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle." As a result, Plaintiff and members of the New York Subclass have been damaged either in the full amount of the purchase price of the Platinum BCAA products or in the difference in value between Platinum BCAA products as warranted and Platinum BCAA products as actually sold.

46. On behalf of himself and other members of the Class and New York Subclass, Plaintiffs seek to enjoin the unlawful acts and practices described herein, to recover their actual damages or fifty dollars, whichever is greater, three times actual damages, and reasonable attorneys' fees.

COUNT II
(False Advertising, New York Gen. Bus. Law § 350)

47. Plaintiff incorporates by reference and re-alleges herein all paragraphs alleged above.

48. Plaintiffs bring this claim individually and on behalf of the members of the proposed New York Subclass against Defendant.

49. Based on the foregoing, Defendant has engaged in consumer-oriented conduct that is deceptive or misleading in a material way which constitutes false advertising in violation of Section 350 of the New York General Business Law.

50. The foregoing advertising was directed at consumers and was likely to mislead a reasonable consumer acting reasonably under the circumstances.

51. These misrepresentations have resulted in consumer injury or harm to the public interest.

52. Plaintiff and members of the New York Subclass were injured because (a) they would not have purchased Platinum BCAA products had they known that they would not

"Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle," (b) they overpaid for Platinum BCAA products because they are sold at a price premium, and (c) Platinum BCAA products did not have the characteristics, uses, or benefits promised, namely that they do not "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle." As a result, Plaintiff and members of the New York Subclass have been damaged either in the full amount of the purchase price of the Platinum BCAA products or in the difference in value between Platinum BCAA products as warranted and Platinum BCAA products as actually sold.

53. On behalf of himself and other members of the New York Subclass, Plaintiff seeks to enjoin the unlawful acts and practices described herein, to recover actual damages or five hundred dollars per violation, whichever is greater, three times actual damages and reasonable attorneys' fees.

COUNT III
Violation of the Magnuson-Moss Warranty Act, 15 U.S.C. §§ 2301, *et seq.*
(On behalf of Plaintiff and the Nationwide Class)

54. Plaintiff hereby incorporates by reference the allegations contained in all preceding paragraphs of this complaint.

55. Plaintiff brings this claim individually and on behalf of the members of the Nationwide Class and New York Subclass against Defendant.

56. Platinum BCAA is a consumer product as defined by 15 U.S.C. § 2301(1).

57. Plaintiff and members of the Nationwide Class and New York Subclass are consumers as defined by 15 U.S.C. § 2301(3).

58. Defendant is a supplier and/or warrantor as defined in 15 U.S.C. § 2301(4) and (5).

59. In connection with the sale of Platinum BCAA, Defendant issued written warranties as defined in 15 U.S.C. § 2301(6), including that the Product "Promotes Muscle Protein Synthesis," "ensures that your muscles are primed for musclebuilding," and provides "key building blocks of muscle."

60. Defendant breached the written warranties because each of the express warranties is provably false and misleading. Platinum BCAA does not stimulate muscle protein synthesis sufficient to build muscle or produce an anabolic response in human subjects, but actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover due to lack of all EAAs.

61. By reason of Defendant's breach of the express written warranties involving Platinum BCAA, Defendant has violated the statutory rights due Plaintiff and members of the Nationwide Class and New York Subclass pursuant to the Magnuson-Moss Warranty Act, 15 U.S.C. § 2301, *et seq.*, thereby damaging Plaintiff and members of the Nationwide Class and New York Subclass.

62. Plaintiff and members of the Nationwide Class and New York Subclass were injured as a direct and proximate result of Defendant's breach because they would not have purchased Platinum BCAA if they had known the truth about the Product, or would have paid substantially less for it.

63. Pursuant to 15 U.S.C. § 2310(d)(1), Plaintiff and members of the Nationwide Class and New York Subclass are entitled to recover the damages caused to them by Defendant's breaches of written warranties, which damages constitute the full purchase price of Platinum

BCAA. In addition, pursuant to 15 U.S.C. § 2310(d)(2), Plaintiff and members of the Nationwide Class and New York Subclass are entitled to recover a sum equal to the aggregate amount of costs and expenses (including attorneys' fees based on actual time expended) determined by the Court to have been reasonably incurred by Plaintiff and members of the Nationwide Class and New York Subclass for and in connection with the commencement and prosecution of this action.

64. Prior to filing this action, Plaintiff, by and through his counsel, provided Defendant with written notice of his claims pursuant to 15 U.S.C. § 2310(e) and also notified Defendant that he was acting on behalf of a Class defined as all persons in the United States who purchased Platinum BCAA. The September 20, 2019 letter is attached hereto as **Exhibit B.**

COUNT IV
Breach Of Express Warranty
(On behalf of Plaintiff and the Nationwide Class)

65. Plaintiff hereby incorporates by reference the allegations contained in all preceding paragraphs of this complaint.

66. Plaintiff brings this claim individually and on behalf of the members of the proposed Nationwide Class and New York Subclass against Defendant.

67. On September 20, 2019, Plaintiff provided Defendant with notice of this claim by letter that complied in all respects with U.C.C. § 2-607(3)(a). The September 20, 2019 letter is attached hereto as **Exhibit B.**

68. Defendant, as the designer, manufacturer, marketer, distributor, and/or seller, expressly warranted that Platinum BCAA "Promotes Muscle Protein Synthesis," "ensures that your muscles are primed for musclebuilding," and provides "key building blocks of muscle."

69. In fact, Platinum BCAA does not stimulate muscle protein synthesis sufficient to induce muscle gain or produce an anabolic response in human subjects. It actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover due to the absence of all EAAs.

70. Mr. Sabatano and members of the Nationwide Class and New York Subclass saw these representations prior to and at the time of purchase, and understood them as representations and warranties that the product would, in fact, "Promote[] Muscle Protein Synthesis," "ensure[] that [their] muscles are primed for musclebuilding," and provide "key building blocks of muscle." Plaintiff and members of the Nationwide Class and New York Subclass relied on these representations and warranties in deciding to purchase Iovate's Platinum BCAA product, and these representations and warranties were part of the basis of the bargain in that they would not have purchased Platinum BCAA if they had known that it would not, in fact, "Promote[] Muscle Protein Synthesis," "ensure[] that [their] muscles are primed for musclebuilding," and provide "key building blocks of muscle."

71. As a direct and proximate result of Defendant's breach of express warranty, Plaintiff and the Nationwide Class and New York Subclass members have been injured and harmed because (a) they would not have purchased Platinum BCAA had they known that it would not "Promote[] Muscle Protein Synthesis," "ensure[] that [their] muscles are primed for musclebuilding," or provide "key building blocks of muscle"; (b) they overpaid for Platinum BCAA because it is sold at a price premium, and (c) Platinum BCAA did not have the characteristics, uses, or benefits as promised, namely it does not "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle." As a result, Plaintiff and members of the Nationwide Class and New York

Subclass have been damaged either in the full amount of the purchase price of the Platinum BCAA product or in the difference in value between Platinum BCAA as warranted and Platinum BCAA as actually sold.

COUNT V
Breach Of Implied Warranty of Merchantability
(On behalf of Plaintiff and the Nationwide Class)

72. Plaintiff hereby incorporates by reference the allegations contained in all preceding paragraphs of this complaint.

73. Plaintiff brings this claim individually and on behalf of the members of the proposed Nationwide Class and New York Subclass against Defendant.

74. On September 20, 2019, Plaintiff provided Defendant with notice of this claim by letter that complied in all respects with U.C.C. § 2-607(3)(a). *See* **Exhibit B**.

75. Defendant breached the warranty implied in the contract for the sale of Platinum BCAA because it could not pass without objection in the trade under the contract description, the goods were not of fair and average quality within the description, and the goods were unfit for their intended and ordinary purpose because Platinum BCAA does not stimulate muscle protein synthesis sufficient to build muscle or produce an anabolic response in human subjects. As a result, Plaintiff and the Nationwide Class and New York Subclass members did not receive the goods as impliedly warranted by Defendant to be merchantable.

76. Plaintiff and the Nationwide Class and New York Subclass members purchased Platinum BCAA in reliance upon Defendant's skill and judgment and the implied warranties of fitness for the purpose.

77. The Platinum BCAA product was not altered by Plaintiff or the Nationwide Class or New York Subclass members.

78. The Platinum BCAA product was defective when it left the exclusive control of Defendant.

79. Defendant knew Platinum BCAA would be purchased and used without additional testing by Plaintiff and the Nationwide Class and New York Subclass members.

80. The BCAA product was defectively designed and unfit for its intended purpose, and Plaintiff and the Nationwide Class and New York Subclass members did not receive the goods as warranted.

81. As a direct and proximate cause of Defendant's breach of warranty, Plaintiff and the Nationwide Class and New York Subclass members have been injured and harmed because (a) they would not have purchased Platinum BCAA had they known that it would not "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle"; (b) they overpaid for Platinum BCAA because it is sold at a price premium, and (c) Platinum BCAA did not have the characteristics, uses, or benefits as promised, namely that it does not "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle." As a result, Plaintiff and members of the Nationwide Class and New York Subclass have been damaged either in the full amount of the purchase price of the Platinum BCAA product or in the difference in value between Platinum BCAA as warranted and Platinum BCAA as actually sold.

COUNT VI
Unjust Enrichment
(On behalf of Plaintiff and the Nationwide Class)

82. Plaintiff hereby incorporates by reference the allegations contained in all preceding paragraphs of this complaint.

83. Plaintiff brings this claim individually and on behalf of the members of the proposed Nationwide Class and New York Subclass against Defendant.

84. Plaintiff and the Nationwide Class and New York Subclass members conferred benefits on Defendant by purchasing Platinum BCAA.

85. Defendant has been unjustly enriched in retaining the revenues derived from Plaintiff and the Nationwide Class and New York Subclass members' purchases of Platinum BCAA. Retention of those monies under these circumstances is unjust and inequitable because Defendant's sale of Platinum BCAA resulted in purchasers being denied the full benefit of their purchase because Platinum BCAA does not "Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle."

86. Because Defendant's retention of the non-gratuitous benefits conferred on it by Plaintiff and the Nationwide Class and New York Subclass members is unjust and inequitable, Defendant must pay restitution to Plaintiff and the Nationwide Class and New York Subclass members for its unjust enrichment, as ordered by the Court.

COUNT VII
Fraud
(On behalf of Plaintiff and the Nationwide Class)

87. Plaintiff hereby incorporates by reference the allegations contained in all preceding paragraphs of this complaint.

88. Plaintiff brings this claim individually and on behalf of the members of the proposed Nationwide Class and New York Subclass against Defendant.

89. As discussed above, Defendant provided Plaintiff and the Nationwide Class and New York Subclass members with false or misleading material information and failed to disclose material facts about Platinum BCAA, including but not limited to the fact that it does not

"Promote[] Muscle Protein Synthesis," "ensure[] that your muscles are primed for musclebuilding," or provide "key building blocks of muscle." In fact, Platinum BCAA actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover. These misrepresentations and omissions were made with knowledge of their falsehood.

90. Dr. Wolfe's study was published in August of 2017, and has been widely publicized in the nutrition and fitness community. Despite the fact that this study has been published for approximately two years, and that other researchers and fitness professionals have joined Dr. Wolfe in concluding that BCAAs, on their own, are ineffective for stimulating muscle growth via increased muscle protein synthesis, Iovate continues to sell its Platinum BCAA product to unsuspecting customers. In short, Iovate continues to sell a product that cannot do what it claims to do based on scientific research which has been widely available for approximately two years. In fact, the research suggests that the Platinum BCAA product actually reduces protein synthesis and perpetuates a catabolic state, directly contrary to the claims on the label. The misrepresentations and omissions made by Defendant, upon which Plaintiff and Class and New York Subclass members reasonably and justifiably relied, were intended to induce and actually induced Plaintiff and Class and New York Subclass members to purchase the Platinum BCAA product.

91. The fraudulent actions of Defendant caused damage to Plaintiff and the Nationwide Class and New York Subclass members, who are entitled to damages and other legal and equitable relief as a result.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff, individually and on behalf of all others similarly situated, seeks judgment against Defendant, as follows:

A. For an order certifying the Nationwide Class and the New York Subclass under Rule 23 of the Federal Rules of Civil Procedure and naming Plaintiff as representative of the Nationwide Class and New York Subclass and Plaintiff's attorneys as Class Counsel to represent the Nationwide Class and New York Subclass Members;

B. For an order declaring that the Defendant's conduct violates the statutes referenced herein;

C. For an order finding in favor of Plaintiff, the Nationwide Class, and the New York Subclass on all counts asserted herein;

D. For compensatory, punitive, and statutory damages in amounts to be determined by the Court and/or jury;

E. For prejudgment interest on all amounts awarded;

F. For an order of restitution and all other forms of equitable monetary relief;

G. For injunctive relief as pleaded or as the Court may deem proper; and

H. For an order awarding Plaintiff and the Nationwide Class and New York Subclass their reasonable attorneys' fees and expenses and costs of suit.

DEMAND FOR TRIAL BY JURY

Plaintiff demands a trial by jury of all causes of action and issues so triable.

Dated: September 25, 2019

Respectfully submitted,

BURSOR & FISHER, P.A.

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EXHIBIT A

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Branched-chain amino acids and muscle protein synthesis in humans: myth or reality?

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Abstract

Go to:

The branched chain amino acids (BCAAs) are leucine, valine and isoleucine. A multi-million dollar industry of nutritional supplements has grown around the concept that dietary supplements of BCAAs alone produce an anabolic response in humans driven by a stimulation of muscle protein synthesis. In this brief review the theoretical and empirical bases for that claim are discussed. Theoretically, the maximal stimulation of muscle protein synthesis in the post-absorptive state in response to BCAAs alone is the difference between muscle protein breakdown and muscle protein synthesis (about 30% greater than synthesis), because the other EAAs required for synthesis of new protein can only be derived from muscle protein breakdown. Realistically, a maximal increase in muscle protein synthesis of 30% is an over-estimate because the obligatory oxidation of EAAs can never be completely suppressed. An extensive search of the literature has revealed no studies in human subjects in which the response of muscle protein synthesis to orally-ingested BCAAs alone was quantified, and only two studies in which the effect of intravenously infused BCAAs alone was assessed. Both of these intravenous infusion studies found that BCAAs decreased muscle protein synthesis as well as protein breakdown, meaning a decrease in muscle protein turnover. The catabolic state in which the rate of muscle protein breakdown exceeded the rate of muscle protein synthesis persisted during BCAA infusion. We conclude that the claim that consumption of dietary BCAAs stimulates muscle protein synthesis or produces an anabolic response in human subjects is unwarranted.

Keywords: Leucine, Valine, Isoleucine, Humans, Anabolic response

Background

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There are a total of twenty amino acids that comprise muscle protein. Nine of the twenty are considered essential amino acids (EAAs), meaning they cannot be produced by the body in physiologically significant amounts, and therefore are crucial components of a balanced diet. Muscle protein is in a

constant state of turnover, meaning that protein synthesis is occurring continuously to replace protein lost as a consequence of protein breakdown. For synthesis of new muscle protein, all the EAAs, along with the eleven non-essential amino acids (NEAAs) that can be produced in the body, must be present in adequate amounts. The branched-chain amino acids leucine, isoleucine and valine are three of the nine EAAs. Leucine is not only a precursor for muscle protein synthesis, but also may play a role as a regulator of intracellular signaling pathways that are involved in the process of protein synthesis (e.g., [1]).

The concept that the BCAAs may have a unique capacity to stimulate muscle protein synthesis has been put forward for more than 35 years. Data supporting this hypothesis have been obtained from studies of the responses of rats. In 1981 Buse [2] reported that in rats the BCAAs may be rate limiting for muscle protein synthesis. Additional studies supported the concept of a unique effect of BCAAs on muscle protein synthesis in rats, although few have studied the response to oral consumption of only BCAAs. Garlick and Grant showed that infusion of a mixture of BCAAs into rats increased the rate of muscle protein synthesis in response to insulin [3], but they did not measure the effects of BCAAs alone. The infusion of BCAAs alone into rats by Kobayashi et al. [4] was shown to induce an increase in muscle protein synthesis, but the response was only transient. Presumably the rate of synthesis quickly became limited by the availability of the other EAAs.

Studies of muscle protein synthesis in rats have limited relevance to human responses. Skeletal muscle comprises a much smaller percentage of the total body mass in rats as compared to humans and regulation of muscle protein synthesis differs in many respects. Thus, in their landmark book on protein metabolism Waterlow and associates concluded from available data that dietary amino acids do not stimulate muscle protein synthesis in rats [5]. While recent work challenges this assertion, the limited stimulatory effect of dietary amino acids on protein synthesis in the rat reflects the fact that under normal post-absorptive conditions there are excess endogenous amino acids available to enable an increase in protein synthesis if the activity of intracellular factors involved in the initiation of protein synthesis is stimulated. Expressed differently, muscle protein synthesis in the rat is apparently limited by the initiation process rather than the translation process. In contrast, as will be discussed below, that does not appear to be the case in humans. Another important distinction between studies investigating the effects of amino acids on muscle protein synthesis in humans and rats relates to the methodologies commonly used. The “flooding dose” technique [6] has usually been used in rat studies. This procedure involves measurement of the incorporation of an amino acid tracer into muscle protein over a very short time window, often as short as 10 min. This approach does not distinguish between a transient and a sustained stimulation of protein synthesis. Only a sustained stimulation of synthesis is relevant physiologically. Consumption of an imbalanced mixture of amino acids, such as the BCAAs, may transiently stimulate protein synthesis by utilizing endogenous stores of the other precursors of protein synthesis. However, endogenous stores of amino acids, such as those in plasma and free intracellular pools, are quite limited and may quickly become depleted. If the stimulation of protein synthesis cannot be sustained, there is little physiological significance. Consequently, the flooding dose technique commonly used to measure muscle protein synthesis in the rat produces results with uncertain relevance to human nutrition. Since BCAA dietary supplements are intended for human consumption, the focus of this short review will be research in human subjects.

The sale of BCAAs as nutritional supplements has become a multi-million dollar business. At the center of the marketing for these products is the widely-believed claim that consumption of BCAAs stimulates muscle protein synthesis, and as a result elicits an anabolic response. BCAAs may also be consumed for the purpose of improving “mental focus”, but we will not consider that application. The primary purpose in this paper to evaluate the assertion that BCAAs alone are anabolic is adequately supported either theoretically or empirically by studies in human subjects. Implicit in our assessment

will be the examination of whether or not the phosphorylation state of the eukaryotic initiation factors plays a rate-controlling role in the regulation of muscle protein synthesis in humans.

Muscle protein turnover and dietary protein intake

Muscle protein is in a constant state of turnover, meaning that new protein is continuously being produced while older proteins are being degraded. The anabolic state has no specific definition, but generally refers to the circumstance in which the rate of muscle protein synthesis exceeds the rate of muscle protein breakdown. The results in a gain of muscle mass. Conventionally the anabolic state is considered to be driven by a stimulation of muscle protein synthesis, but theoretically could also result from an inhibition of muscle protein breakdown.

The overriding metabolic goal of consuming BCAA supplements is to maximize the anabolic state. It is widely asserted that BCAAs induce an anabolic state by stimulating muscle protein synthesis. An abundant availability of all EAAs is a requisite for a significant stimulation of muscle protein synthesis [7]. Muscle protein synthesis will be limited by the lack of availability of any of the EAAs, whereas a shortage of NEAAs can be compensated for by increased de novo production of the deficient NEAAs [7]. In the post-prandial state following a meal containing protein, all of the EAA precursors required for new muscle protein synthesis can be derived from either the elevated plasma concentrations resulting from digestion of the consumed protein or from recycling from protein breakdown. In this circumstance of abundant availability of EAAs the rate of muscle protein synthesis exceeds the rate of breakdown, thereby producing an anabolic state. In the post-absorptive state the plasma EAA levels fall below the post-prandial values because amino acids are no longer being absorbed. As a result, EAAs are no longer taken up by muscle, but rather released by muscle into plasma [8]. This catabolic state of muscle protein in the post-absorptive state enables continued availability of EAAs for other tissues to maintain the rate of protein synthesis at the expense of muscle protein, which can be considered to play a role as the reservoir of EAAs for the rest of the body to draw upon.

Since EAAs cannot be produced in the body and there is a net release of EAAs from muscle, in the post-absorptive state the only source of EAA precursors for muscle protein synthesis is intracellular EAAs derived from muscle protein breakdown [8]. In addition to being reincorporated into muscle protein via synthesis, some EAAs released from muscle protein breakdown may be partially oxidized within muscle, thereby making them unavailable for reincorporation into muscle protein. EAAs released from muscle protein breakdown that are not reincorporated into muscle protein or oxidized within muscle tissue are released into plasma, whereupon they can either be taken up by other tissues as precursors for protein synthesis or irreversibly oxidized [9]. Thus, the rate of muscle protein synthesis will always be lower than the rate of muscle protein breakdown in the post-absorptive state, owing to the net flux of EAAs from protein breakdown into plasma and to oxidative pathways. Expressed differently, it is impossible for muscle protein synthesis to exceed the rate of muscle protein breakdown when the precursors are derived entirely from protein breakdown, and thus an anabolic state cannot occur in the absence of exogenous amino acid intake.

Are BCAAs anabolic in the post-absorptive state?

Theoretical considerations

All EAA precursors for muscle protein synthesis in the post-absorptive state are derived from muscle protein breakdown. It has been consistently reported that in normal post-absorptive humans the rate of muscle protein breakdown exceeds the rate of muscle protein synthesis by approximately 30% [10]. Consumption of BCAAs alone (i.e., without the other EAAs) can only increase muscle protein synthesis in the post-absorptive state by increasing the efficiency of recycling of EAAs from protein breakdown back into protein synthesis, as opposed to either being released in to plasma or oxidized.

This is because all 9 EAAs (as well as 11 NEAAs) are required to produce muscle protein, and EAAs cannot be produced in the body. If only 3 EAAs are consumed, as is the case with consumption of BCAAs, then protein breakdown is the only source of the remaining EAAs required as precursors for muscle protein synthesis. It is therefore theoretically impossible for consumption of only BCAAs to create an anabolic state in which muscle protein synthesis exceeds muscle protein breakdown. If the generous assumption is made that BCAA consumption improves the efficiency of recycling of EAAs from muscle protein breakdown to muscle protein synthesis by 50%, then this would translate to a 15% increase in the rate of muscle protein synthesis(30% recycled in basal state X 50% improvement in recycling = 15% increase in synthesis). Further, a 50% reduction in the release of EAAs into plasma from muscle would also reduce the plasma and intracellular pools of free EAAs. Figure Fig. 1 schematically illustrates these principles. Since a 50% improvement in recycling efficiency would be about the reasonable maximal limit, this means that the maximal stimulation of muscle protein synthesis could not exceed 15%. This would correspond to an increase in the fractional synthetic rate of muscle from a basal value of about 0.050%/h in the basal state to 0.057%/h, and this difference in the fractional synthetic rate (FSR) of protein would be difficult to accurately measure [11].

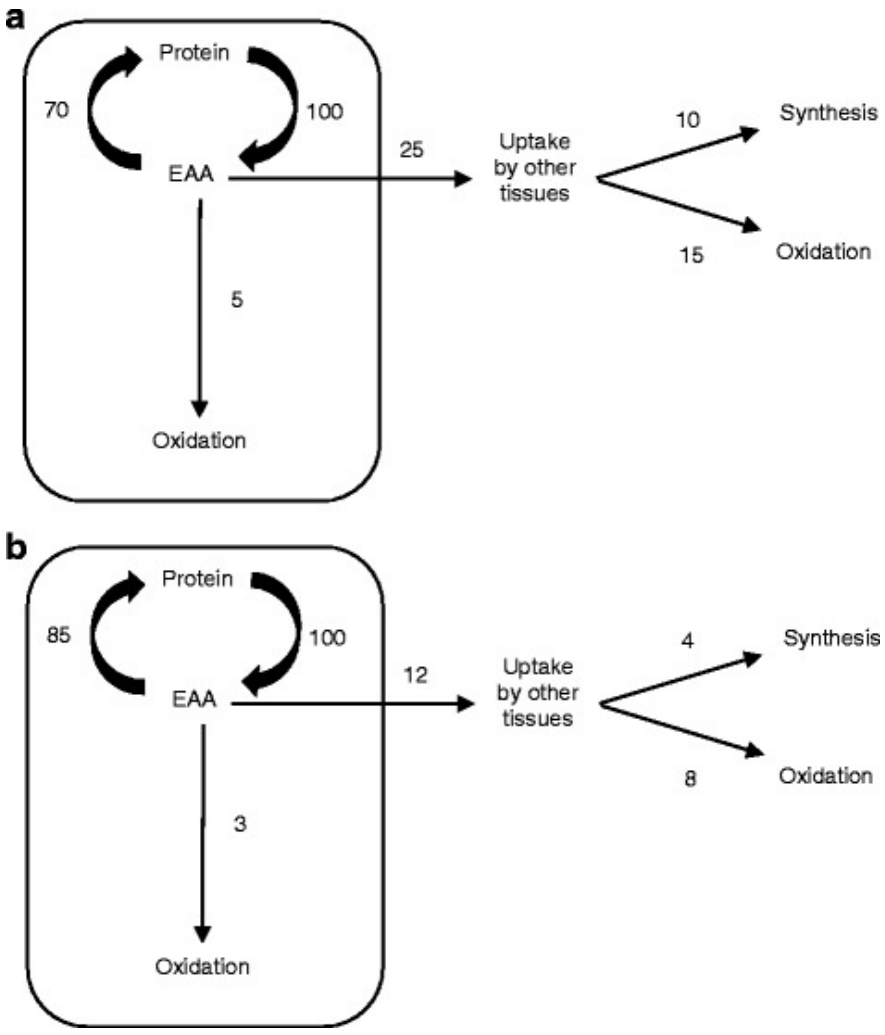

Fig. 1

Schematic representation of the recycling of essential amino acids (EAAs) from muscle protein breakdown into muscle protein synthesis in the post-absorptive state. Arbitrary units are used for simplicity and are based on measured rates of each pathway in post-absorptive human subjects [10]. **a** Normal circumstance

in the post-absorptive state. Approximately 70% of EAAs from muscle protein breakdown are recycled into protein synthesis [10]. There is a net efflux of approximately 85% of EAAs released from protein breakdown, which can either be taken up and incorporated into protein in other tissues or oxidize. About 15% of EAAs from protein breakdown are partially oxidized in muscle and unavailable for protein synthesis. The figures for outward flux and intracellular oxidation of EAAs are averages, since some EAAs, such as phenylalanine, are not oxidized at all in muscle. **b** Representation of a 50% increase in efficiency of recycling of EAAs from muscle protein breakdown into protein synthesis. In this example there would be an increase in synthesis from 70 to 80 units, or 20%. Protein synthesis can never exceed protein breakdown in the post-absorptive state, since protein breakdown is the only source of EAAs

Empirical results

BCAAs have been administered intravenously in the only studies determining the response of muscle protein metabolism in human subjects to BCAAs alone. While the infusion of BCAAs is not the conventional manner in which a dietary supplement would be consumed, intravenously infused and orally-ingested amino acids have been shown to elicit comparable effects on muscle protein synthesis in other circumstances [12]. Consequently, it is reasonable to evaluate the papers in which the response of muscle protein synthesis to the intravenous infusion of BCAAs in human subjects.

Louard et al. [13] used the forearm balance method to quantify the response to the intravenous infusion of a mixture of BCAAs for 3 h in 10 post-absorptive subjects. The forearm balance method involves the measurement of the uptake and release of individual EAAs (leucine and phenylalanine in this case) and their isotopically-labelled counterparts. Rates of disappearance (Rd) and appearance (Ra) of phenylalanine and leucine are calculated. With the assumption that the balance across the muscle of leucine and phenylalanine is representative of all EAAs, Rd. of phenylalanine is taken to be a reflection of muscle protein synthesis, since protein synthesis is the only fate of phenylalanine taken up by muscle from plasma. The Rd. of leucine cannot be interpreted with regard to protein synthesis, as leucine taken up by muscle can be oxidized as well as incorporated into protein. The 3 h infusion of BCAAs increased plasma concentrations of all 3 BCAAs four-fold, while the concentrations of other EAAs decreased [13]. Rather than being stimulated by the BCAA infusion, muscle protein synthesis decreased from 37+/− 3 to 21 +/− 2 nmol/min/100 ml leg (statistically significant, $p < 0.05$) [13]. There was no significant change in net phenylalanine balance, indicating that muscle protein breakdown was also reduced an amount similar to the reduction in muscle protein synthesis. The balance between muscle protein synthesis and breakdown remained negative, meaning that the catabolic state persisted and an anabolic state was not produced. The simultaneous decreases in muscle protein synthesis and breakdown during BCAA infusion can be described as decreased muscle protein turnover.

Similar results were obtained by the same investigators when they extended the infusion of BCAA to 16 h in 8 normal volunteers and determined if chronic elevation of BCAAs stimulated muscle protein synthesis [14]. The same forearm balance methodology was used as in the previous study to calculate muscle protein synthesis and breakdown. The 16 h infusion increase BCAA concentrations from 5 to 8 fold [14], which is as much as double the levels achieved with a normal dose of BCAAs ingested orally [15]. As in the previous study, muscle protein synthesis (as reflected by phenylalanine Rd) was reduced in the subjects receiving BCAAs as compared to saline infusion from 36 +/− 5 to 27 +/ −2 nmol/min/100 ml.Muscle protein breakdown was also reduced, meaning that muscle protein turnover was reduced as well, and a catabolic state persisted.

We can conclude from these two studies that BCAA infusion not only fails to increase the rate of muscle protein synthesis in human subjects, but actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover. The catabolic state was not reversed to an anabolic state in

either study. Further, a sustained reduction in the rate of muscle protein turnover would be expected to have a detrimental effect on muscle strength, even if muscle mass is maintained. Muscle protein turnover renews the muscle fibers and results in increased efficiency of contraction at the single fiber level [16], which is reflected in increased strength in vivo, independent of muscle mass [17, 18].

The failure of muscle protein synthesis to increase significantly in response to the infusion of BCAAs alone is as expected according to the theoretical considerations discussed above and illustrated in Fig. Fig. 1 with regard to the requirement for all EAAs to sustain an increase. Instead, since muscle protein breakdown decreased, the availability of EAAs also fell, which in turn actually reduced the rate of muscle protein synthesis.

Are the anabolic signaling factors rate-limiting in the post-absorptive state?

The claim that muscle protein synthesis is stimulated by the BCAAs stems at least in part from the observation that intracellular anabolic signaling is increased, including the activation state of key factors involved in the initiation of protein synthesis [1]. The theory that activation of intracellular anabolic signaling factors causes an increased rate of muscle protein synthesis has become entrenched in modern concepts of the regulation of muscle protein synthesis. Increased anabolic signaling in response to BCAAs has been cited as evidence of a stimulation of muscle protein synthesis, even in the absence of the measurement of muscle protein synthesis (e.g., [1]). However, activation of the anabolic signaling pathways can only coincide with increased muscle protein synthesis if there are ample EAAs to provide the necessary precursors to produce complete protein.

Dissociation of the phosphorylation state of the signaling factors and muscle protein synthesis in humans has been shown in a variety of circumstances when the availability of all of the EAAs is limited. For example, an increase in insulin concentration (for example, as a result of glucose intake) is a potent activator of the anabolic signaling pathways, but this fails to increase muscle FSR because of a deficiency of EAAs [19]. Conversely, consumption of a small amount (3 g) of EAAs stimulates muscle protein synthesis without affecting initiation factor activity e.g., Akt, S6 kinase, and 4E–BP1 [20]. A small increase in plasma concentrations of EAAs would have no effect if protein synthesis was limited by the activation state of the initiation factors. In the studies cited above in which BCAAs were infused intravenously, it is reasonable to presume that such a large increase in BCAA concentrations would have activated the signaling factors, yet muscle protein synthesis actually decreased due to lack of availability of EAAs resulting from a decrease in protein breakdown. Thus, in human subjects provision of EAAs can increase muscle protein synthesis in the absence of any change in the activation of initiation factors, and activation of the initiation factors in the absence of consumption of all of the EAAs has no effect on muscle protein synthesis. These results can only be interpreted as demonstrating that the rate-limiting control of basal muscle protein synthesis in humans is availability of all of the EAAs as opposed to anabolic signaling factor activity. This conclusion casts further doubt on the role of dietary supplement of BCAAs alone as stimulators of muscle protein synthesis.

When all evidence and theory is considered together, it is reasonable to conclude that there is no credible evidence that ingestion of a dietary supplement of BCAAs alone results in a physiologically-significant stimulation of muscle protein. In fact, available evidence indicates that BCAAs actually decrease muscle protein synthesis. All EAAs must be available in abundance for increased anabolic signaling to translate to accelerated muscle protein synthesis.

BCAA co-ingestion with other nutrients

The focus of this review has been the response to BCAAs alone, as this is the logical intent of BCAA nutritional supplements. As in the case of consumption of BCAAs alone, there are limited studies of the co–ingestion of BCAAs with other nutrients. When BCAAs or an isonitrogenous mixture of threonine, methionine and histidine were administered to human subjects along with carbohydrate, the

rate of muscle protein synthesis decreased equally in both groups, indicating no unique role of the BCAAs [21]. Similarly, consumption of a mixture of BCAAs to carbohydrate after resistance exercise did not increase the anabolic signaling factors to any greater extent than carbohydrate alone [22]. Thus, available evidence does not support the notion of a special anabolic effect of the BCAAs when given with carbohydrate.

In contrast to the lack of an interactive effect between BCAAs and carbohydrate, BCAAs may enhance the anabolic effect of a protein meal. For example, the addition of 5 g of BCAAs to a beverage containing 6.25 g whey protein increased muscle protein synthesis to a level comparable to that induced by 25 g of whey protein [23]. This result suggests that one or more of the BCAAs might be rate limiting for the stimulation of muscle protein synthesis by whey protein, or that the extra BCAAs induced a greater potential for an anabolic response of muscle to whey protein by activating the initiation factors. In either case, the response of BCAAs in conjunction with intact protein is a different issue that the effect of BCAAs alone, since the intact protein provides all of the EAAs necessary to produce an intact protein.

Individual effects of leucine, valine and isoleucine

In this paper we have considered only the response to mixtures of BCAAs. The responses to individual BCAAs (i.e., leucine, valine or isoleucine) might differ from the combination of the three for several reasons. Evidence indicates that leucine alone may exert and anabolic response (e.g., [24]), while no such data exists for isoleucine or valine. Thus, it might be expected that leucine alone would be more effective than the combination of all of the BCAAs. However, there are two significant limitations of a dietary supplement of leucine alone. First, the same issues that limit the extent of stimulation of muscle protein synthesis by BCAAs alone regarding the availability of the other EAAs necessary for the production of intact muscle protein also limit the response to leucine alone. Second, elevation of the plasma concentration of leucine activates the metabolic pathway that oxidizes all of the BCAAs. As a result, ingestion of leucine alone results in a decrease in the plasma concentrations of both valine and isoleucine. The availability of valine and isoleucine may therefore become rate limiting for muscle protein synthesis when leucine alone is consumed. This may be why long-term outcome studies with dietary leucine supplementation have failed to yield positive results [25]. The principal rationale for a dietary supplement containing all of the BCAAs as opposed to leucine alone is to overcome the decreases in plasma concentrations of valine and isoleucine that would occur when leucine is given alone.

While a dietary supplement with all of the BCAAs will overcome the decreases in concentration resulting from consumption of leucine alone, the addition of valine and isoleucine may nonetheless limit the effectiveness of leucine alone due to competition for transport into muscle cells. The BCAAs are all actively transported into cells, including muscle cells, by the same transport system. Therefore, when provided together the BCAAs compete with each other for transport into the cells. If one of the BCAAs (e.g., leucine) is rate limiting for protein synthesis, addition of the other two BCAAs might limit the stimulation of protein synthesis because of reduced entry of leucine into the cell. The BCAAs also compete with other amino acids for transport, including phenylalanine, and this competition could affect the intramuscular availability of other EAAs. As a result of competition for transporters, it is possible that leucine alone, for example, could have a transitory stimulatory effect on muscle protein synthesis (e.g., [21]) where the BCAAs fail to elicit such response [13, 14].

Conclusion

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A physiologically-significant increase in the rate of muscle protein synthesis requires adequate availability of all amino acid precursors. The source of EAAs for muscle protein synthesis in the post-absorptive state is the free intracellular pool. Intracellular free EAAs that are available for

incorporation into protein are derived from muscle protein breakdown. Under normal conditions about 70% of EAAs released by muscle protein breakdown are reincorporated into muscle protein. The efficiency of reincorporation of EAAs from protein breakdown back into muscle protein can only be increased to a limited extent. For this fundamental reason, a dietary supplement of BCAAs alone cannot support an increased rate of muscle protein synthesis. The availability of the other EAAs will rapidly become rate limiting for accelerated protein synthesis. Consistent with this perspective, the few studies in human subjects have reported decreases, rather than increases, in muscle protein synthesis after intake of BCAAs. We conclude that dietary BCAA supplements alone do not promote muscle anabolism.

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EXHIBIT B

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September 20, 2019

Via Email Only

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Re: Violation of the Magnuson-Moss Warranty Act, 15 U.S.C. § 2301, et seq.; violation of the U.C.C. §§ 2-313, 2-314; New York General Business Law §§ 349 & 350; and all other applicable laws

To Whom It May Concern,

This letter serves as a preliminary notice and demand for corrective action by Iovate Health Sciences International Inc. ("Defendant," "MuscleTech," or "You") arising from breaches of warranty under the Magnuson-Moss Warranty Act on behalf of our client, Tom Sabatano, and a class of all similarly situated purchasers of MuscleTech's Platinum 100% BCAA 8:1:1. This letter also serves as notice pursuant to U.C.C. § 2-607(3)(a) concerning the breaches of express and implied warranties described herein. This letter additionally serves as notice of violations of all applicable consumer protection laws, including, but not limited to, New York General Business Law §§ 349 & 350.

You have participated in the manufacture, marketing, and sale of the Platinum 100% BCAA 8:1:1 dietary supplement. MuscleTech's Platinum 100% BCAA 8:1:1 supplement has been marketed and sold to "Build Muscle" and "Promote[] Muscle Protein Synthesis" (the "Misrepresentations"). However, a peer-reviewed study authored by Dr. Robert R. Wolfe, published in the Journal of the International Society of Sports Nutrition in August 2017, entitled "Branched-chain amino acids and muscle protein synthesis in humans: myth or reality?" concludes that "the claim that consumption of dietary BCAAs stimulates muscle protein synthesis or produces an anabolic response in human subjects is unwarranted."[1] In reviewing human studies involving consumption of BCAA supplements, Dr. Wolfe concludes that "BCAA infusion not only fails to increase the rate of muscle protein synthesis in human subjects, but actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover." Accordingly, the representations made on the Products' labeling and associated website are false and misleading.

[1] A copy of Dr. Wolfe's study is attached hereto as Exhibit A.

Mr. Sabatano purchased and used MuscleTech's Platinum 100% BCAA 8:1:1 supplement in reliance on the Misrepresentations. Defendant expressly warranted that MuscleTech's Platinum 100% BCAA 8:1:1 supplement would build muscle and promote muscle protein synthesis. Defendant breached that express warranty because BCAA supplements, on their own, cannot build muscle, as the label suggests. The ineffectiveness of BCAA supplements for building muscle has been conclusively established by the above-referenced study, among others. *See* U.C.C. § 2-313.

Defendant's conduct is also a deceptive business practice under all applicable consumer protection laws, including, but not limited to, New York General Business Law §§ 349 & 350.

Mr. Sabatano is acting on behalf of a class defined as all persons in the United States who purchased MuscleTech's Platinum 100% BCAA 8:1:1, and a subclass of all persons in New York who purchased MuscleTech's Platinum 100% BCAA 8:1:1.

To cure these defects, we demand that you (1) cease and desist from further sales of mislabeled Platinum 100% BCAA 8:1:1; (2) issue an immediate recall of mislabeled Platinum 100% BCAA 8:1:1 products; and (3) make full restitution to all purchasers of your Platinum 100% BCAA 8:1:1 products.

We further demand that you preserve all documents and other evidence which refer or relate to any of the above-described practices including, but not limited to, the following:

1. All documents concerning the design, development, supply, production, extraction, and/or testing of MuscleTech's Platinum 100% BCAA 8:1:1;

2. All documents concerning the advertisement, marketing, or sale of Platinum 100% BCAA 8:1:1;

3. All documents concerning communications with any retailer involved in the marketing or sale of Platinum 100% BCAA 8:1:1;

4. All documents concerning communications with purchasers of Platinum 100% BCAA 8:1:1;

5. All documents concerning communications with federal or state regulators; and

6. All documents concerning the total revenue derived from sales of Platinum 100% BCAA 8:1:1 in the United States.

If you contend that any statement in this letter is inaccurate in any respect, please provide us with your contentions and supporting documents promptly.

We are willing to negotiate to attempt to resolve the demands asserted in this letter. If you wish to enter into such discussions, please contact me right away. If I do not hear from you promptly, I will take that as an indication that you are not interested in doing so.

Very truly yours,

Philip L. Fraietta

EXHIBIT A

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Branched-chain amino acids and muscle protein synthesis in humans: myth or reality?

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Abstract

Go to:

The branched chain amino acids (BCAAs) are leucine, valine and isoleucine. A multi-million dollar industry of nutritional supplements has grown around the concept that dietary supplements of BCAAs alone produce an anabolic response in humans driven by a stimulation of muscle protein synthesis. In this brief review the theoretical and empirical bases for that claim are discussed. Theoretically, the maximal stimulation of muscle protein synthesis in the post-absorptive state in response to BCAAs alone is the difference between muscle protein breakdown and muscle protein synthesis (about 30% greater than synthesis), because the other EAAs required for synthesis of new protein can only be derived from muscle protein breakdown. Realistically, a maximal increase in muscle protein synthesis of 30% is an over-estimate because the obligatory oxidation of EAAs can never be completely suppressed. An extensive search of the literature has revealed no studies in human subjects in which the response of muscle protein synthesis to orally-ingested BCAAs alone was quantified, and only two studies in which the effect of intravenously infused BCAAs alone was assessed. Both of these intravenous infusion studies found that BCAAs decreased muscle protein synthesis as well as protein breakdown, meaning a decrease in muscle protein turnover. The catabolic state in which the rate of muscle protein breakdown exceeded the rate of muscle protein synthesis persisted during BCAA infusion. We conclude that the claim that consumption of dietary BCAAs stimulates muscle protein synthesis or produces an anabolic response in human subjects is unwarranted.

Keywords: Leucine, Valine, Isoleucine, Humans, Anabolic response

Background

Go to:

There are a total of twenty amino acids that comprise muscle protein. Nine of the twenty are considered essential amino acids (EAAs), meaning they cannot be produced by the body in physiologically significant amounts, and therefore are crucial components of a balanced diet. Muscle protein is in a

constant state of turnover, meaning that protein synthesis is occurring continuously to replace protein lost as a consequence of protein breakdown. For synthesis of new muscle protein, all the EAAs, along with the eleven non-essential amino acids (NEAAs) that can be produced in the body, must be present in adequate amounts. The branched-chain amino acids leucine, isoleucine and valine are three of the nine EAAs. Leucine is not only a precursor for muscle protein synthesis, but also may play a role as a regulator of intracellular signaling pathways that are involved in the process of protein synthesis (e.g., [1]).

The concept that the BCAAs may have a unique capacity to stimulate muscle protein synthesis has been put forward for more than 35 years. Data supporting this hypothesis have been obtained from studies of the responses of rats. In 1981 Buse [2] reported that in rats the BCAAs may be rate limiting for muscle protein synthesis. Additional studies supported the concept of a unique effect of BCAAs on muscle protein synthesis in rats, although few have studied the response to oral consumption of only BCAAs. Garlick and Grant showed that infusion of a mixture of BCAAs into rats increased the rate of muscle protein synthesis in response to insulin [3], but they did not measure the effects of BCAAs alone. The infusion of BCAAs alone into rats by Kobayashi et al. [4] was shown to induce an increase in muscle protein synthesis, but the response was only transient. Presumably the rate of synthesis quickly became limited by the availability of the other EAAs.

Studies of muscle protein synthesis in rats have limited relevance to human responses. Skeletal muscle comprises a much smaller percentage of the total body mass in rats as compared to humans and regulation of muscle protein synthesis differs in many respects. Thus, in their landmark book on protein metabolism Waterlow and associates concluded from available data that dietary amino acids do not stimulate muscle protein synthesis in rats [5]. While recent work challenges this assertion, the limited stimulatory effect of dietary amino acids on protein synthesis in the rat reflects the fact that under normal post-absorptive conditions there are excess endogenous amino acids available to enable an increase in protein synthesis if the activity of intracellular factors involved in the initiation of protein synthesis is stimulated. Expressed differently, muscle protein synthesis in the rat is apparently limited by the initiation process rather than the translation process. In contrast, as will be discussed below, that does not appear to be the case in humans. Another important distinction between studies investigating the effects of amino acids on muscle protein synthesis in humans and rats relates to the methodologies commonly used. The “flooding dose” technique [6] has usually been used in rat studies. This procedure involves measurement of the incorporation of an amino acid tracer into muscle protein over a very short time window, often as short as 10 min. This approach does not distinguish between a transient and a sustained stimulation of protein synthesis. Only a sustained stimulation of synthesis is relevant physiologically. Consumption of an imbalanced mixture of amino acids, such as the BCAAs, may transiently stimulate protein synthesis by utilizing endogenous stores of the other precursors of protein synthesis. However, endogenous stores of amino acids, such as those in plasma and free intracellular pools, are quite limited and may quickly become depleted. If the stimulation of protein synthesis cannot be sustained, there is little physiological significance. Consequently, the flooding dose technique commonly used to measure muscle protein synthesis in the rat produces results with uncertain relevance to human nutrition. Since BCAA dietary supplements are intended for human consumption, the focus of this short review will be research in human subjects.

The sale of BCAAs as nutritional supplements has become a multi-million dollar business. At the center of the marketing for these products is the widely-believed claim that consumption of BCAAs stimulates muscle protein synthesis, and as a result elicits an anabolic response. BCAAs may also be consumed for the purpose of improving “mental focus”, but we will not consider that application. The primary purpose in this paper to evaluate the assertion that BCAAs alone are anabolic is adequately supported either theoretically or empirically by studies in human subjects. Implicit in our assessment

will be the examination of whether or not the phosphorylation state of the eukaryotic initiation factors plays a rate-controlling role in the regulation of muscle protein synthesis in humans.

Muscle protein turnover and dietary protein intake

Muscle protein is in a constant state of turnover, meaning that new protein is continuously being produced while older proteins are being degraded. The anabolic state has no specific definition, but generally refers to the circumstance in which the rate of muscle protein synthesis exceeds the rate of muscle protein breakdown. The results in a gain of muscle mass. Conventionally the anabolic state is considered to be driven by a stimulation of muscle protein synthesis, but theoretically could also result from an inhibition of muscle protein breakdown.

The overriding metabolic goal of consuming BCAA supplements is to maximize the anabolic state. It is widely asserted that BCAAs induce an anabolic state by stimulating muscle protein synthesis. An abundant availability of all EAAs is a requisite for a significant stimulation of muscle protein synthesis [7]. Muscle protein synthesis will be limited by the lack of availability of any of the EAAs, whereas a shortage of NEAAs can be compensated for by increased de novo production of the deficient NEAAs [7]. In the post-prandial state following a meal containing protein, all of the EAA precursors required for new muscle protein synthesis can be derived from either the elevated plasma concentrations resulting from digestion of the consumed protein or from recycling from protein breakdown. In this circumstance of abundant availability of EAAs the rate of muscle protein synthesis exceeds the rate of breakdown, thereby producing an anabolic state. In the post-absorptive state the plasma EAA levels fall below the post-prandial values because amino acids are no longer being absorbed. As a result, EAAs are no longer taken up by muscle, but rather released by muscle into plasma [8]. This catabolic state of muscle protein in the post-absorptive state enables continued availability of EAAs for other tissues to maintain the rate of protein synthesis at the expense of muscle protein, which can be considered to play a role as the reservoir of EAAs for the rest of the body to draw upon.

Since EAAs cannot be produced in the body and there is a net release of EAAs from muscle, in the post-absorptive state the only source of EAA precursors for muscle protein synthesis is intracellular EAAs derived from muscle protein breakdown [8]. In addition to being reincorporated into muscle protein via synthesis, some EAAs released from muscle protein breakdown may be partially oxidized within muscle, thereby making them unavailable for reincorporation into muscle protein. EAAs released from muscle protein breakdown that are not reincorporated into muscle protein or oxidized within muscle tissue are released into plasma, whereupon they can either be taken up by other tissues as precursors for protein synthesis or irreversibly oxidized [9]. Thus, the rate of muscle protein synthesis will always be lower than the rate of muscle protein breakdown in the post-absorptive state, owing to the net flux of EAAs from protein breakdown into plasma and to oxidative pathways. Expressed differently, it is impossible for muscle protein synthesis to exceed the rate of muscle protein breakdown when the precursors are derived entirely from protein breakdown, and thus an anabolic state cannot occur in the absence of exogenous amino acid intake.

Are BCAAs anabolic in the post-absorptive state?

Theoretical considerations

All EAA precursors for muscle protein synthesis in the post-absorptive state are derived from muscle protein breakdown. It has been consistently reported that in normal post-absorptive humans the rate of muscle protein breakdown exceeds the rate of muscle protein synthesis by approximately 30% [10]. Consumption of BCAAs alone (i.e., without the other EAAs) can only increase muscle protein synthesis in the post-absorptive state by increasing the efficiency of recycling of EAAs from protein breakdown back into protein synthesis, as opposed to either being released in to plasma or oxidized.

This is because all 9 EAAs (as well as 11 NEAAs) are required to produce muscle protein, and EAAs cannot be produced in the body. If only 3 EAAs are consumed, as is the case with consumption of BCAAs, then protein breakdown is the only source of the remaining EAAs required as precursors for muscle protein synthesis. It is therefore theoretically impossible for consumption of only BCAAs to create an anabolic state in which muscle protein synthesis exceeds muscle protein breakdown. If the generous assumption is made that BCAA consumption improves the efficiency of recycling of EAAs from muscle protein breakdown to muscle protein synthesis by 50%, then this would translate to a 15% increase in the rate of muscle protein synthesis(30% recycled in basal state X 50% improvement in recycling = 15% increase in synthesis). Further, a 50% reduction in the release of EAAs into plasma from muscle would also reduce the plasma and intracellular pools of free EAAs. Figure Fig. 1 schematically illustrates these principles. Since a 50% improvement in recycling efficiency would be about the reasonable maximal limit, this means that the maximal stimulation of muscle protein synthesis could not exceed 15%. This would correspond to an increase in the fractional synthetic rate of muscle from a basal value of about 0.050%/h in the basal state to 0.057%/h, and this difference in the fractional synthetic rate (FSR) of protein would be difficult to accurately measure [11].

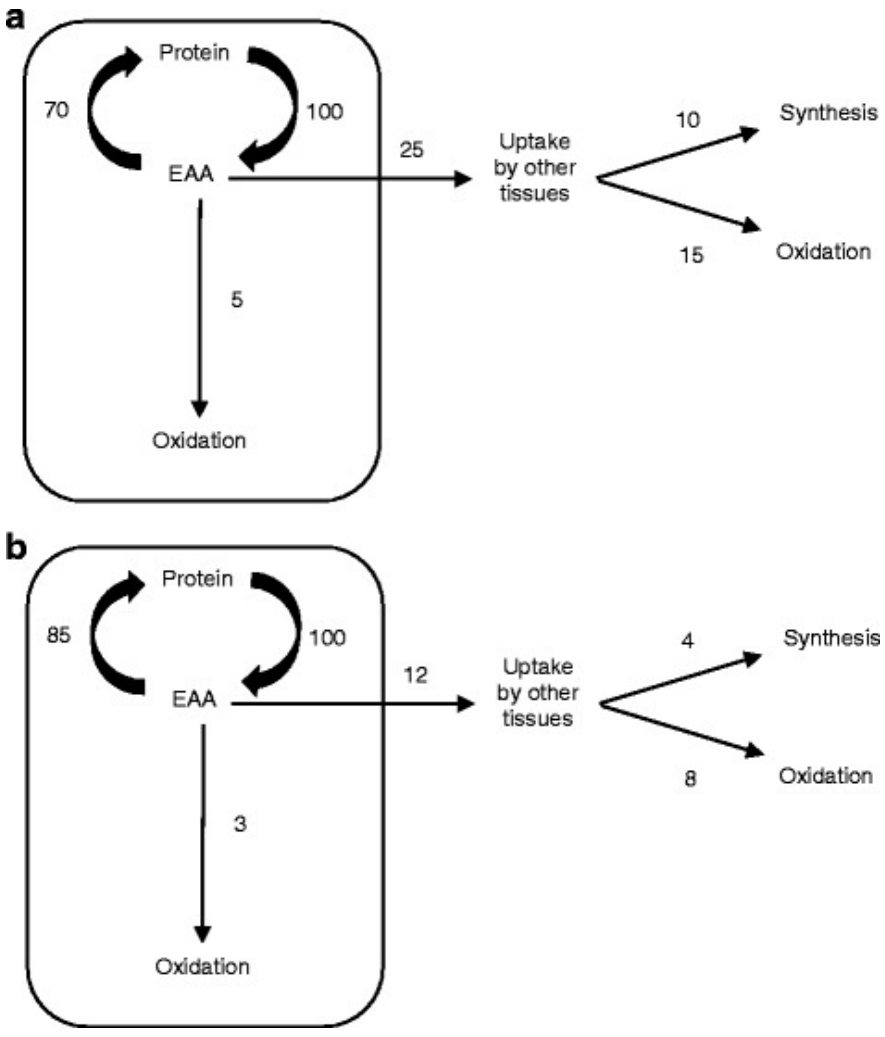

Fig. 1

Schematic representation of the recycling of essential amino acids (EAAs) from muscle protein breakdown into muscle protein synthesis in the post-absorptive state. Arbitrary units are used for simplicity and are based on measured rates of each pathway in post-absorptive human subjects [10]. **a** Normal circumstance

in the post-absorptive state. Approximately 70% of EAAs from muscle protein breakdown are recycled into protein synthesis [10]. There is a net efflux of approximately 85% of EAAs released from protein breakdown, which can either be taken up and incorporated into protein in other tissues or oxidize. About 15% of EAAs from protein breakdown are partially oxidized in muscle and unavailable for protein synthesis. The figures for outward flux and intracellular oxidation of EAAs are averages, since some EAAs, such as phenylalanine, are not oxidized at all in muscle. **b** Representation of a 50% increase in efficiency of recycling of EAAs from muscle protein breakdown into protein synthesis. In this example there would be an increase in synthesis from 70 to 80 units, or 20%. Protein synthesis can never exceed protein breakdown in the post-absorptive state, since protein breakdown is the only source of EAAs

Empirical results

BCAAs have been administered intravenously in the only studies determining the response of muscle protein metabolism in human subjects to BCAAs alone. While the infusion of BCAAs is not the conventional manner in which a dietary supplement would be consumed, intravenously infused and orally-ingested amino acids have been shown to elicit comparable effects on muscle protein synthesis in other circumstances [12]. Consequently, it is reasonable to evaluate the papers in which the response of muscle protein synthesis to the intravenous infusion of BCAAs in human subjects.

Louard et al. [13] used the forearm balance method to quantify the response to the intravenous infusion of a mixture of BCAAs for 3 h in 10 post-absorptive subjects. The forearm balance method involves the measurement of the uptake and release of individual EAAs (leucine and phenylalanine in this case) and their isotopically-labelled counterparts. Rates of disappearance (Rd) and appearance (Ra) of phenylalanine and leucine are calculated. With the assumption that the balance across the muscle of leucine and phenylalanine is representative of all EAAs, Rd. of phenylalanine is taken to be a reflection of muscle protein synthesis, since protein synthesis is the only fate of phenylalanine taken up by muscle from plasma. The Rd. of leucine cannot be interpreted with regard to protein synthesis, as leucine taken up by muscle can be oxidized as well as incorporated into protein. The 3 h infusion of BCAAs increased plasma concentrations of all 3 BCAAs four-fold, while the concentrations of other EAAs decreased [13]. Rather than being stimulated by the BCAA infusion, muscle protein synthesis decreased from 37+/− 3 to 21 +/− 2 nmol/min/100 ml leg (statistically significant, $p < 0.05$) [13]. There was no significant change in net phenylalanine balance, indicating that muscle protein breakdown was also reduced an amount similar to the reduction in muscle protein synthesis. The balance between muscle protein synthesis and breakdown remained negative, meaning that the catabolic state persisted and an anabolic state was not produced. The simultaneous decreases in muscle protein synthesis and breakdown during BCAA infusion can be described as decreased muscle protein turnover.

Similar results were obtained by the same investigators when they extended the infusion of BCAA to 16 h in 8 normal volunteers and determined if chronic elevation of BCAAs stimulated muscle protein synthesis [14]. The same forearm balance methodology was used as in the previous study to calculate muscle protein synthesis and breakdown. The 16 h infusion increase BCAA concentrations from 5 to 8 fold [14], which is as much as double the levels achieved with a normal dose of BCAAs ingested orally [15]. As in the previous study, muscle protein synthesis (as reflected by phenylalanine Rd) was reduced in the subjects receiving BCAAs as compared to saline infusion from 36 +/− 5 to 27 +/ −2 nmol/min/100 ml.Muscle protein breakdown was also reduced, meaning that muscle protein turnover was reduced as well, and a catabolic state persisted.

We can conclude from these two studies that BCAA infusion not only fails to increase the rate of muscle protein synthesis in human subjects, but actually reduces the rate of muscle protein synthesis and the rate of muscle protein turnover. The catabolic state was not reversed to an anabolic state in

either study. Further, a sustained reduction in the rate of muscle protein turnover would be expected to have a detrimental effect on muscle strength, even if muscle mass is maintained. Muscle protein turnover renews the muscle fibers and results in increased efficiency of contraction at the single fiber level [16], which is reflected in increased strength in vivo, independent of muscle mass [17, 18].

The failure of muscle protein synthesis to increase significantly in response to the infusion of BCAAs alone is as expected according to the theoretical considerations discussed above and illustrated in Fig. Fig. 1 with regard to the requirement for all EAAs to sustain an increase. Instead, since muscle protein breakdown decreased, the availability of EAAs also fell, which in turn actually reduced the rate of muscle protein synthesis.

Are the anabolic signaling factors rate-limiting in the post-absorptive state?

The claim that muscle protein synthesis is stimulated by the BCAAs stems at least in part from the observation that intracellular anabolic signaling is increased, including the activation state of key factors involved in the initiation of protein synthesis [1]. The theory that activation of intracellular anabolic signaling factors causes an increased rate of muscle protein synthesis has become entrenched in modern concepts of the regulation of muscle protein synthesis. Increased anabolic signaling in response to BCAAs has been cited as evidence of a stimulation of muscle protein synthesis, even in the absence of the measurement of muscle protein synthesis (e.g., [1]). However, activation of the anabolic signaling pathways can only coincide with increased muscle protein synthesis if there are ample EAAs to provide the necessary precursors to produce complete protein.

Dissociation of the phosphorylation state of the signaling factors and muscle protein synthesis in humans has been shown in a variety of circumstances when the availability of all of the EAAs is limited. For example, an increase in insulin concentration (for example, as a result of glucose intake) is a potent activator of the anabolic signaling pathways, but this fails to increase muscle FSR because of a deficiency of EAAs [19]. Conversely, consumption of a small amount (3 g) of EAAs stimulates muscle protein synthesis without affecting initiation factor activity e.g., Akt, S6 kinase, and 4E–BP1 [20]. A small increase in plasma concentrations of EAAs would have no effect if protein synthesis was limited by the activation state of the initiation factors. In the studies cited above in which BCAAs were infused intravenously, it is reasonable to presume that such a large increase in BCAA concentrations would have activated the signaling factors, yet muscle protein synthesis actually decreased due to lack of availability of EAAs resulting from a decrease in protein breakdown. Thus, in human subjects provision of EAAs can increase muscle protein synthesis in the absence of any change in the activation of initiation factors, and activation of the initiation factors in the absence of consumption of all of the EAAs has no effect on muscle protein synthesis. These results can only be interpreted as demonstrating that the rate-limiting control of basal muscle protein synthesis in humans is availability of all of the EAAs as opposed to anabolic signaling factor activity. This conclusion casts further doubt on the role of dietary supplement of BCAAs alone as stimulators of muscle protein synthesis.

When all evidence and theory is considered together, it is reasonable to conclude that there is no credible evidence that ingestion of a dietary supplement of BCAAs alone results in a physiologically-significant stimulation of muscle protein. In fact, available evidence indicates that BCAAs actually decrease muscle protein synthesis. All EAAs must be available in abundance for increased anabolic signaling to translate to accelerated muscle protein synthesis.

BCAA co-ingestion with other nutrients

The focus of this review has been the response to BCAAs alone, as this is the logical intent of BCAA nutritional supplements. As in the case of consumption of BCAAs alone, there are limited studies of the co–ingestion of BCAAs with other nutrients. When BCAAs or an isonitrogenous mixture of threonine, methionine and histidine were administered to human subjects along with carbohydrate, the

rate of muscle protein synthesis decreased equally in both groups, indicating no unique role of the BCAAs [21]. Similarly, consumption of a mixture of BCAAs to carbohydrate after resistance exercise did not increase the anabolic signaling factors to any greater extent than carbohydrate alone [22]. Thus, available evidence does not support the notion of a special anabolic effect of the BCAAs when given with carbohydrate.

In contrast to the lack of an interactive effect between BCAAs and carbohydrate, BCAAs may enhance the anabolic effect of a protein meal. For example, the addition of 5 g of BCAAs to a beverage containing 6.25 g whey protein increased muscle protein synthesis to a level comparable to that induced by 25 g of whey protein [23]. This result suggests that one or more of the BCAAs might be rate limiting for the stimulation of muscle protein synthesis by whey protein, or that the extra BCAAs induced a greater potential for an anabolic response of muscle to whey protein by activating the initiation factors. In either case, the response of BCAAs in conjunction with intact protein is a different issue that the effect of BCAAs alone, since the intact protein provides all of the EAAs necessary to produce an intact protein.

Individual effects of leucine, valine and isoleucine

In this paper we have considered only the response to mixtures of BCAAs. The responses to individual BCAAs (i.e., leucine, valine or isoleucine) might differ from the combination of the three for several reasons. Evidence indicates that leucine alone may exert and anabolic response (e.g., [24]), while no such data exists for isoleucine or valine. Thus, it might be expected that leucine alone would be more effective than the combination of all of the BCAAs. However, there are two significant limitations of a dietary supplement of leucine alone. First, the same issues that limit the extent of stimulation of muscle protein synthesis by BCAAs alone regarding the availability of the other EAAs necessary for the production of intact muscle protein also limit the response to leucine alone. Second, elevation of the plasma concentration of leucine activates the metabolic pathway that oxidizes all of the BCAAs. As a result, ingestion of leucine alone results in a decrease in the plasma concentrations of both valine and isoleucine. The availability of valine and isoleucine may therefore become rate limiting for muscle protein synthesis when leucine alone is consumed. This may be why long-term outcome studies with dietary leucine supplementation have failed to yield positive results [25]. The principal rationale for a dietary supplement containing all of the BCAAs as opposed to leucine alone is to overcome the decreases in plasma concentrations of valine and isoleucine that would occur when leucine is given alone.

While a dietary supplement with all of the BCAAs will overcome the decreases in concentration resulting from consumption of leucine alone, the addition of valine and isoleucine may nonetheless limit the effectiveness of leucine alone due to competition for transport into muscle cells. The BCAAs are all actively transported into cells, including muscle cells, by the same transport system. Therefore, when provided together the BCAAs compete with each other for transport into the cells. If one of the BCAAs (e.g., leucine) is rate limiting for protein synthesis, addition of the other two BCAAs might limit the stimulation of protein synthesis because of reduced entry of leucine into the cell. The BCAAs also compete with other amino acids for transport, including phenylalanine, and this competition could affect the intramuscular availability of other EAAs. As a result of competition for transporters, it is possible that leucine alone, for example, could have a transitory stimulatory effect on muscle protein synthesis (e.g., [21]) where the BCAAs fail to elicit such response [13, 14].

Conclusion

Go to:

A physiologically-significant increase in the rate of muscle protein synthesis requires adequate availability of all amino acid precursors. The source of EAAs for muscle protein synthesis in the post-absorptive state is the free intracellular pool. Intracellular free EAAs that are available for

incorporation into protein are derived from muscle protein breakdown. Under normal conditions about 70% of EAAs released by muscle protein breakdown are reincorporated into muscle protein. The efficiency of reincorporation of EAAs from protein breakdown back into muscle protein can only be increased to a limited extent. For this fundamental reason, a dietary supplement of BCAAs alone cannot support an increased rate of muscle protein synthesis. The availability of the other EAAs will rapidly become rate limiting for accelerated protein synthesis. Consistent with this perspective, the few studies in human subjects have reported decreases, rather than increases, in muscle protein synthesis after intake of BCAAs. We conclude that dietary BCAA supplements alone do not promote muscle anabolism.

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Authors' contributions

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Sole author of this review paper, RRW, has drafted, read and approved the final manuscript.

Notes

Go to:

Ethics approval and consent to participate

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Consent for publication

Go to:

Not Applicable.

Competing interests

Go to:

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