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UYARI

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ÖNSÖZ

Biyokimya, birçok tıp ve sağlık biliminden farklı olarak, sezgiyle değil; moleküler düzeyde analiz ve kavrayışla anlaşılabilen bir bilimdir. Bu yönüyle okuyucusunu yalnızca bilgiye değil, aynı zamanda düşünsel derinliğe de davet eder. Üstelik biyokimya, sınırları sürekli genişleyen disiplinlerarası bir evrendir. Embriyonik gelişimden karsinogenez süreçlerine, ilaçların moleküler etkilerinden metabolik ağların düzenlenmesine kadar biyolojik olayların en temel açıklamaları, artık biyokimyasal düzeyde yapılabilmektedir.

Beslenme bilimleri ise biyokimyanın sunduğu bu derinliği günlük yaşamla buluşturan dinamik bir alandır. Hücresel düzeyde gerçekleşen reaksiyonlar yalnızca laboratuvar ortamlarında değil, her bir öğünümüzde ve her molekül değişiminde kendini gösterir. Bu nedenle beslenme biyokimyası yalnızca bir bilim değil; sağlık, hastalık, yaşam ve iyilik halinin moleküler haritasıdır. Beslenme biyokimyası, beslenmeye bilimsel bir yaklaşım getirir. Sadece "ne" olduğunu (beslenme gereksinimleri) değil, aynı zamanda bu öğelerin hücresel ve moleküler düzeydeki işlevlerini de açıklayarak insan sağlığı açısından neden gerekli olduklarını ele alır. Her vaka çalışması, ya yeni bir keşfe zemin hazırlar ya da beslenmeyle ilgili fizyolojik süreçlerin etki mekanizmalarının anlaşılmasına katkı sunar.

Elinizdeki bu kitap yalnızca beslenme ve diyetetik alanında eğitim gören öğrenciler ile bu alanda çalışan uzmanlara değil; aynı zamanda sağlık alanında lisans, yüksek lisans ve doktora düzeyinde öğrenim gören öğrencilere ve yaşamlarını bilime adamış değerli araştırmacılara da hitap etmektedir. Biyokimyasal süreçlerin anlaşılmasına rehberlik etmeyi amaçlayan bu eser, hem temel kavramlara hem de güncel bilimsel bilgilere yer vermektedir. Metabolik yollar ile besin öğeleri arasındaki ilişkiler, karmaşadan uzak, sistematik ve anlaşılır bir dille sunularak okuyucunun kavrayışını derinleştirmeyi hedeflemektedir.

Bu eserin hazırlanmasında bilimsel doğruluk kadar eğitsel yalınlığa da önem verilmiştir. Her bölüm, öğrencilerin öğrenme sürecini destekleyecek şekilde yapılandırılmış; karmaşık biyokimyasal mekanizmaların, klinik ve beslenme ile ilişkili örneklerle kavranması sağlanmıştır.

Kitabın hazırlık sürecinde bilimsel katkılarıyla bizi destekleyen, görüş ve önerileriyle çalışmamıza yön veren tüm meslektaşlarıma ve akademik yolculuğumuzda bize ilham veren değerli hocalarımız başta Prof.Dr. Hüseyin ESECELİ

olmak üzere, Doç.Dr. Elif GÜNALAN, Doç.Dr. Ceyhan HACIOĞLU, Doç.Dr. Hacı Ömer YILMAZ, Doç.Dr. Sevil KARAHAN YILMAZ, Dr.Öğr.Üyesi Tuba ONAY, Dr.Öğr.Üyesi Mustafa ÖZGÜR, Dr.Öğr.Üyesi Çiler ÖZENİR, Dr.Öğr.Üyesi Hatice SERÇE, Dr.Öğr.Üyesi Funda TAMER, Dr.Öğr.Üyesi Aybala TAZEOĞLU, Dr.Öğr.Üyesi Gonca YILDIRIM, Arş. Gör. Canan ALTINSOY ve Uzm.Dyt. Zeynep ERCAN KARAKAYA'ya içtenlikle teşekkür ederim. Ayrıca teknik süreçlerde emeği geçen yayınevi çalışanlarına da şükranlarımı sunarım. Bu kitap aynı zamanda onların özverisinin de bir ürünüdür.

Beslenme biyokimyası alanına katkı sunmasını temenni ettiğimiz bu çalışmanın; öğrencilerimize, akademisyenlerimize ve sağlık profesyonellerine faydalı olmasını diliyorum.

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BÖLÜM 1

KARBONHİDRATLAR VE KARBONHİDRAT METABOLİZMASI

Mustafa ÖZGÜR[1]
Hacı Ömer YILMAZ[2]

Giriş

Karbonhidratlar, $(CH_2O)_n$ kapalı formülüne sahip çok yönlü bir molekül sınıfıdır. Organizmalarda depolanan enerjinin önemli bir formudur ve neredeyse diğer tüm biyomoleküllerin metabolik öncüleridir. Karbonhidratların proteinler ve lipidlerle konjugatları, hücre büyümesi, dönüşümü ve diğer süreçlerde önemli olan tanıma olayları da dahil olmak üzere çeşitli işlevleri yerine getirmektedir (1).

Karbonhidratlar, doğada en çok bulunan organik molekül sınıfıdır. Fotosentez sırasında yeşil bitkiler, algler ve bazı bakteriler tarafından alınan güneş enerjisi, yeryüzünde her gün 250 milyar kilogramdan fazla CO_2'yi primer metabolit olan karbonhidratlara dönüştürmektedir. Ayrıca, karbonhidratlar neredeyse tüm diğer biyomoleküllerin (sekonder metabolitlerin) metabolik öncüleridir. Karbonhidratların parçalanması, canlıların yaşamını devam ettirmesi gereken enerjiyi sağlamaktadır (2). Karbonhidratlar diğer moleküllerle kovalent olarak bağlanabilir. Bu glikokonjugatlar bitkilerde, hayvanlarda ve bakterilerde hücre duvarlarının ve hücre dışı yapıların önemli bileşenleridir. Bu tür moleküllerin

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ribitol ve arabitol ile D-ksilüloz ve riboz oldukça yüksektir. Bu şeker alkollerinin aşırı yüksek konsantrasyonları beyin omurilik sıvısında da bulunur ve beyin omurilik sıvısındaki miyoinozitol konsantrasyonu azalır (167).

Transaldolaz eksikliği: Pentoz fosfat yolunun geri dönüşümlü kısmında bulunan transaldolaz, transketolaz ile koordineli bir şekilde pentoz fosfatları heksoz fosfatlara geri dönüştürür. Transaldolaz eksikliği otozomal resesif geçişlidir. Eksikliğinde ara metabolik maddelerden türetilen eritritol, arabitol ve ribitol gibi poliollerin birikmesine neden olur. Transaldolaz aktivitesi fibroblastlarda, eritrositler ve lenfoblastlarda belirlenebilir (167).

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BÖLÜM 2

LİPİDLER VE LİPİD METABOLİZMASI

Tuba ONAY[1]

Lipidlerin Tanıtımı, Sınıflandırılması ve Görevleri

Lipidler, suda çözünmeyen ancak organik çözücülerde çözünen organik bileşikler olarak tanımlanmaktadır (1). Yapılarında karbon, hidrojen ve oksijen atomları, bazı durumlarda fosfor, azot, kükürt ve diğer elementler de bulunmaktadır. Bu kimyasal özellikler, yağ asitleri, fosfolipidler, steroller, sfingolipidler, terpenler vb. birçok molekülde mevcuttur. Lipidler, dokuların büyümesi, gelişimi ve bakımında önemli rol oynamaktadır (2-3). Önemli görevlerinden bazıları şunlardır: Hücre zarında fosfolipidlerin ayrılmaz bir parçasını olarak görev alma, birincil enerji kaynağı olarak kullanılma (9 kkal/g), bebeklerde günlük enerji ihtiyacının %50'den fazlasını sağlama, lökotrien, prostaglandinler, tromboksanlar vb. eikosanoidler ve dokosanoidlerin sentezinde görev alma, ikincil haberci ve gen düzenleyici olarak hareket etme (4-5).

Lipidler "basit" ve "karmaşık" gruplara ayrılmaktadır. Basit lipidler, hidroliz sırasında en fazla farklı iki tür veren (örneğin, açilgliseroller: yağ asitleri ve gliserol) ve karmaşık lipidler (örneğin, gliserofosfolipidler: yağ asitleri, gliserol ve baş grup) hidroliz sırasında üç veya daha fazla farklı tür veren lipidlerdir (6,7). Ayrıca "türetilmiş" lipidler (basit lipidlerin hidrolize edilmesiyle türetilen alkoller ve yağ asitleri) adı verilen üçüncü bir ana grup da tanımlanmıştır (8).

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BÖLÜM 3

YAĞLAR

Sevil KARAHAN YILMAZ[1]

Keton Cisimciklerinin Oluşumu ve Düzenlenmesi

Keton cisimciklerinin kandaki konsantrasyonu çok düşüktür, ancak kontrolsüz tip 1 diyabet hastalarında ve vücut yağ azaltımı sırasında meydana gelen hızlandırılmış yağ asidi oksidasyonu durumlarında (düşük enerjili veya düşük karbonhidratlı diyet uygulama süreçlerinde) artar. Yağ hücreleri tarafından dolaşıma bol miktarda serbest yağ asidi salınır ve bu miktar dokuların yağ asitlerini okside etme kapasitesi üzerindedir (1). Açlık, tedavi edilmemiş tip I diyabet veya düşük/sıfır karbonhidrat içeriğine sahip yüksek yağlı bir diyet sırasında, mitokondriyal oksalasetat glukoneogenez yoluyla glikoza dönüşür ve böylece sitrik asit döngüsü bloke olur (2). Beyin ve kırmızı kan hücreleri de dahil olmak üzere glikoz gerektiren dokular yağ asitlerini enerji için kullanamaz ve alternatif yakıtlara olan ihtiyaçları artar.

Karaciğer, ketogenezle aşırı serbest yağ asitlerini keton cisimciklerine dönüştürür (1). Ketogenez için substrat, yağ asitlerinin β-oksidasyon ürünü olan asetil-CoA'dır (2). β-oksidasyonun ardından karaciğer, aşırı asetil-CoA'yı asetoasetat, b-hidroksibutirat ve asetona dönüştürür (1) (Şekil 1). Asetoasetat ve β-hidroksibutirat karaciğerde daha fazla oksitlenmez, bunun yerine kan yoluyla periferik dokulara taşınır ve burada asetil-CoA'ya geri dönüştürülürülerek rikarboksilik asit (TCA) döngüsüyle oksitlenir. Aseton, küçük bir oyuncudur ve kanda asetoasetatın kendiliğinden dekarboksilasyonu ile ortaya çıkar. Keton

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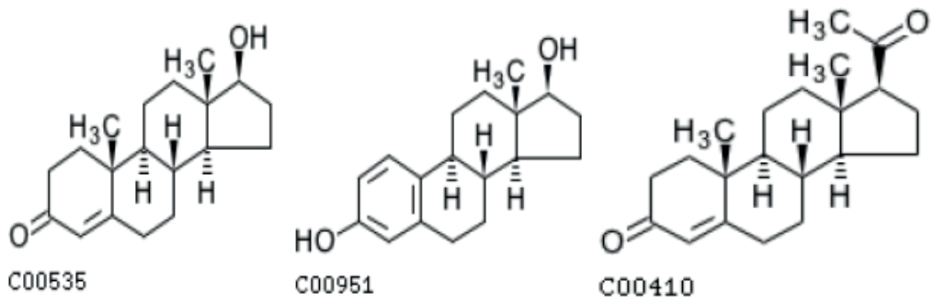
ve progesteron üretmeye uyarır. FSH, yumurtalık foliküllerinin büyümesini düzenler ve testis spermatogenezini uyarır (3).



Şekil 15. Gonadol steroid hormonlarının formülü

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BÖLÜM 4

PROTEİNLER VE PROTEİN METABOLİZMASI

Uğur GÜNŞEN[1]

PROTEİNLER

Sağlığın ve zindeliğin sürdürülmesi, organizmaların gıda bulunabilirliği ve kalitesinin güvenilmez olabileceği karmaşık bir ortamda yeterli ve dengeli bir beslenmeyi zorunlu kılmaktadır (1). "Protein" kelimesi, Yunanca'da "birincil öneme sahip" anlamını taşıyan πρώτα *(prota)* sözcüğünden gelmektedir. Bu isim, 1838'de proteinleri ilk kez tanımlayan Jöns Jakob Berzelius tarafından verilmiştir.Vücudun temel yapısal bileşenleri olarak kabul edilen proteinler, pek çok amino asidin peptit bağlarıyla birleştirilmesinden oluşan azotlu makromoleküllerdir. 1926'da James B. Sumner'in üreaz enziminin bir protein olduğunu göstermesine kadar proteinlerin canlılar için ne derece önemli olduğu tam olarak anlaşılamamıştır. Yapısı çözülen ilk proteinler arasında insülin ve miyoglobin bulunmaktadır.

Protein içeren bir besin tüketildiğinde, proteinler amino asitlere parçalanırlar ve amino asit havuzunda toplanırlar. Amino asitler, vücut tarafından kullanılarak protein haline dönüştürülmekte, kas, hormon ve enzimlerin yapısına katılmaktadırlar (2). Amino asitlerin bazıları diğer amino asitlerden sentezlenebilirken, diğer bazı amino asitler (esansiyel amino asitler) mutlaka dışarıdan besinlerle birlikte alınmalıdırlar (3,4,2).

En iyi protein kaynakları; et (sığır, tavuk, balık), soya fasulyesi ve kuru fasulye gibi besinlerdir. Et gibi hayvansal protein kaynaklarında esansiyel amino asit

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zamanda, normal olarak büyüyen hücrelerin çoğalmasını da etkilerler. Bu nedenle anemi, kellik, pullu cilt vb. birçok yan etkiye neden olurlar. Kanseri kontrol etmek için yaygın olarak kullanılırlar. Sülfonamidler gibi sülfa ilaçları, Para Amino Benzoik Asid (PABA)'in yapısal analoglarıdırlar ve pürinlerin ve dolayısıyla nükleik asitlerin (DNA ve RNA) sentezini dolaylı olarak azaltırlar. Bunlar mikroorganizmalar tarafından folik asit sentezinin engellenmesi için kullanılabilirler. Folik asit sentezlenmediği ve diyet yoluyla sağlandığı için sülfonamidlerin insanlar üzerinde hiçbir etkisi yoktur (269-271).

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BÖLÜM 5

AMİNO ASİT METABOLİZMASI

Funda TAMER[1]

1.Giriş

Amino asitler, proteinlerin temel yapı taşı olan organik moleküllerdir. Her amino asitte farklı bir yan zincir bulunur ve bu grup amino asitlerin kendine özgü kimyasal özelliklerinin ve dolayısıyla proteinlerin yapı ve fonksiyonlarının belirlenmesinde temel öneme sahiptir. Amino asitlerin bilinen en önemli fonksiyonu protein sentezinde yer almalıdır. Bununla birlikte, çok sayıda metabolik süreçte kritik rol oynarlar. Yan zincir, her amino asidin özgün kimyasal özelliklerini belirler (1,2).

2. Amino Asitlerin Kimyasal Yapısı ve Özellikleri

2.1. Amino Asitlerin Genel Yapısı

Tüm α-amino asitler, ortak bir temel kimyasal yapıya sahiptir: α-karbona bağlı 4 farklı grup bulunmaktadır (Şekil 1.1).Hidrojen atomu

» Karboksil grubu (-COOH)
» Amino grubu (-NH_2)
» Farklı bir yan zincir (R grubu)

Merkezi C atomu kiral C özelliği gösterir (glisin hariç; R grubu da H atomudur) (1).

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BÖLÜM 6

ENERJİ METABOLİZMASI VE DİYET

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Giriş

Beslenme sağlıklı ve dengeli bir yaşam sürdürülebilmesi için en elzem fizyolojik gereksinimlerimizden biridir. Tüketilen gıdalardaki kimyasal bağ enerjisi hücresel solunum olarak da bilinen çeşitli biyokimyasal reaksiyonlar yoluyla vücudun kullanabileceği enerjiye çevrilir. Bu süreç organizmanın değişen koşullara adapte olabilmesi, büyümesi, gelişmesi ve fiziksel aktivitelerinin devamlılığı için oldukça önemlidir (1). Ancak; enerji metabolizması sadece gıdalardaki karbonhidrat, yağ ve proteinlerin oksidasyonu sonucu hücresel enerji üretimi ile sınırlı değildir. Bazal metabolizma hızı, fiziksel aktivite ve besinlerin termik etkisi yoluyla enerji harcanması, serbest enerjinin fazla olması durumunda depolanması ve eksikliğinde ilgili birime transfer edilmesi de bu sürece dahildir.

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literatürel çalışmalar ışığında diyetsel müdahaleler, beslenme alışkanlıkları ve gıda takviyelerinin enerji metabolizmasına potansiyel etkileri tartışılmıştır. Araştırmalarda önerilen diyetsel müdahalelerin gerek hayvan modellerinde gerekse çeşitli klinik araştırmalarda incelendiği ve birbiriyle uyumlu sonuçlar elde edildiği görülmektedir. Bu durum, gelecekte obezite vb. hastalıkların yönetimine ilişkin diyetsel stratejiler hakkında umut vadeder niteliktedir. Ancak, biyoaktif bileşenlerin uygulandığı klinik çalışmaların artırılması gerekmektedir. Bununla birlikte, bu bileşenleri içeren farklı ilaç taşıyıcı sistemler tasarlanmalı ve biyoyararlınım, etkinlik ve güvenirliğe ilişkin araştırmalara odaklanılmalıdır. Böylece, enerji metabolizmasının modülasyonu daha kontrolllü, hızlı ve efektif bir şekilde sağlanabilir.

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BÖLÜM 7

AÇLIK VE TOKLUK METABOLİZMASI

Gonca YILDIRIM[1]

Giriş

Besin alımının düzenlenmesindeki temel aşamalar açlık, doyum ve tokluktur. Açlık, bireyde yemek yeme sürecini başlatan uyarıcıdır. Doyum, bir öğün sırasında hissedilen ve öğünün sonlanmasını sağlayan doluluk hissidir. Tokluk, doluluk hissinin sürdüğü zaman dilimidir. Bu farklı aşamalar, beyin-bağırsak-karaciğer-yağ dokusu ekseni tarafından düzenlenir. Beslenme davranışının düzenlenmesinde homeostatik ve hedonik bileşenler bir araya gelerek rol oynar (1).

Tokluğun homeostatik düzenlenmesi

Gastrik ve İntestinal mekanizmalar

Tokluk sinyallerinin başladığı en olası yerin proksimal mide olduğu belirtilmiştir. Mide, gerilme ve uzama hassasiyetine sahip mekanoreseptörlerle donatılmıştır. Gerilme hassas reseptörler, midenin dolmasına bağlı tokluk sinyallerini iletir. Mide gevşediğinde bu reseptörler daha az aktif olur, ancak mide doldukça ve mide içi basınç arttıkça tekrar aktive olurlar. Bu mekanik sinyaller, vagus siniri yoluyla beyindeki traktus solitarius çekirdeği (nucleus of the tractus solitarius, NTS) bölgesine iletilir. Bu süreçte ***leptin*** hormonu vagus siniri aracılığıyla gönderilen tokluk sinyallerinin etkisini artırır (2).

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BÖLÜM 8

VİTAMİNLER

Hatice SERÇE[1]

Vitaminler

Kimyasal yapılarında karbon (C) elementi içeren mikro besin ögelerine "vitamin" denir. Minerallerden farklı olarak vitaminler, organik bileşikler olup, ortak bir yapıları yoktur, her vitaminin kimyasal yapısı kendine özgüdür. Makro besin ögelerinin aksine, vitaminler, vücutta yapı maddesi olarak kullanılmaz ve vücuda enerji sağlamazlar (1-3). Vücutta makro besin ögelerinin metabolizmasında, vücut fonksiyonlarının ve bağışıklık sisteminin düzenlenmesinde görevli olup, işlevlerini belirli tepkimelere özgü aktif yapıları ile hücrede gerçekleştirirler (1-4). Vitamin gereksinimleri vücutta depolanan kadar olup miligram (mg), mikrogram (mcg) ya da internasyonel ünite (IU) düzeyinde ifade edilir. Yaş, cinsiyet, büyüme ve gelişme, gebelik ve emziklilik, kısıtlı diyet tüketimi, hastalık durumları ve kronik ilaç kullanımı vitamin gereksinimini etkileyen etmenlerdir (1, 2).

Vitaminler, vücutta ya yetersiz sentezlenen ya da hiç sentezlenemeyen, diyetle alınması elzem besinlerdir. Örneğin D vitamini, deride güneş ışığı ile yeterli süre temas edilirse; K vitamini ve Biotin, bağırsak florasında gerekli bakteriler bulunursa; Niasin, vücutta triptofan aminoasiti yeterliyse ve gerekli enzim varsa sentezlenir. A vitamini de ön maddesi β-karoten bağırsakta varsa sentezlenir (2). Endojen sentezlenen vitamin düzeyleri, gereksinimi kısmi karşılar ve diyetle yeterli düzeyde alınmadığında vitamin yetersizliğine özgü

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Fazla Alımı-Toksisite: C vitamini besinlerle fazla alındığında toksik etki yapmaz, ancak intravenöz yolla yüksek miktarda (5-10 g/gün) tek doz verildiğinde ozmotik diyare ve poliüri ile sonuçlanır. Vitaminin fazlası idrarda okzalat atımını artırdığı için ürolitiyazis riskini artırır ve demir emiliminde azalmaya neden olabilir. C vitamini uzun süre fazla alındığında prooksidandır. Vitamin desteği olarak alınan C vitamini için güvenilebilir üst limit yaş gruplarına göre değişmekle birlikte, yetişkinlerde 2000 mg/gün'dür. Kronik hastalıklardan korunmak için antioksidan olarak C vitamininin rutinde takviye alınmasının klinikte anlamlı bir yararı gösterilememiştir (1-8, 81-84).

Not: Hemokromatozis hastalığında, dokularda demir birikimi nedeniyle bu hastalıktan etkilenen kişilerin diyetinde C vitamini kısıtlanır (2, 4, 6).

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BÖLÜM 9

MAKRO MİNERALLER VE ORGANİZMADAKİ GÖREVLERİ KALSİYUM-FOSFOR MİNERALİ

Aybala TAZEOĞLU[1]

Makro Mineraller ve Organizmadaki Görevleri

Mineraller doğada oldukça yaygın olan inorganik özellikte maddelerdir. Canlının büyümesi ve gelişmesi, yaşamın devamlılığı ve sağlığın korunması için inorganik özellikte olan minerallere gereksinim vardır. Vücudunuzun %4-5'i gibi çok küçük bir kısmını oluştururlar ve buna rağmen metabolizmanın düzenlenmesinde önemli görevleri vardır, ek olarak diş, kemik, kas, kan ve diğer dokularda da mineraller mevcuttur. Yapılarının inorganik olmasından kaynaklı ısı ve diğer besin işleme yöntemlerinde kayba uğramazlar. Günlük alınması gereken miktar 250 mg'ın üzerinde olan mineraller makro minerallerdir ve sodyum, potasyum ve klor elektrolitleri ile kalsiyum, magnezyum ve fosfor bu gruptadırlar (1).

Mineraller toksik elementlere düşmandır. Bu, uygun miktar ve oranların varlığında toksik elementleri nötralize etmek, vücutta birikmesini önlemek ve hatta vücuttan uzaklaştırmak için çalıştığı anlamına gelir. Vücudun metabolizmasında hayati bir rol oynadığı için bir organizmanın hayatta kalması veya normal işleyişi için gerekli olan kimyasal bir elementtir. Bu elementler genellikle nispeten küçük miktarlarda gereklidir ve genellikle diyet yoluyla elde edilir (1,2)

Bir makro element eksikliği, insanlar tarafından büyük miktarlarda ihtiyaç duyulan bir veya daha fazla temel mineralin eksikliğini ifade eder. Makro element

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ayrılabilir. Ana semptomlar, yetersiz ATP üretimi nedeniyle enerji tükenmesiyle hücresel düzeyde açıklanabilir. Semptomlar arasında solunum yetmezliği olan solunum kasları da dahil olmak üzere kas güçsüzlüğü, kemik ağrısı ve kaybı, nöropatiler, titreme ve nöbetler, hemoliz ve anemi, metabolik asidoz ve insülin direnci bulunur (149).

Çocuklarda raşitizm ve kemik deformiteleri belirgindir. Çocuklarda, fosfat metabolizmasının doğuştan gelen kusurları en sık görülen nedenler arasındadır ve böbrek fosfat taşıyıcılarındaki veya endokrin düzenleyicilerindeki gen kusurlarından kaynaklanabilir (150). Kalıtsal hipofosfateminin en yaygın biçimi , X›e bağlı hipofosfatemiye neden olan *PHEX* genindeki mutasyonlardan kaynaklanır (149). Yetişkinlerde, hipofosfatemi bağırsak emiliminin azalması, iç kaymalar veya böbrek kayıplarından kaynaklanabilir (151). GFR ölçümü, hipofosfateminin nedenini belirlemeye yardımcı olabilir.

Hiperfosfatemi

Plazma Pi düzeyleri >1,46 mmol/l (4,5 mg/dl) hiperfosfatemi olarak kabul edilir. Hiperfosfateminin yaygın nedenleri ileri evre kronik böbrek yetmezliğinde, akut böbrek hasarı, D vitamini takviyeleriyle birlikte veya tek başına fosfat takviyeleri, hipoparatiroidizm, metabolik ve solunum asidozu veya rabdomiyoliz ve tümör lizis sendromudur (152-154). Akut olarak, hiperfosfatemi hipokalsemiye neden olurken, uzun vadeli sonuçlar çoğunlukla inflamasyon, damarların ektopik kalsifikasyonları ve oldukça artmış kardiyovasküler morbidite ve mortalite ile bağlantılıdır (155-157).

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BÖLÜM 10

KÜKÜRT

Ceyhan HACIOĞLU[1]

Giriş

Canlı organizmalarda kükürt en temel elementlerden biri ve insan vücudunda yedinci en bol bulunan mineraldir. Kükürtün atom ağırlığı 32.064, atom numarası 16'dır ve kimyasal sembolü "S" ile gösterilir. Antoine Lavoisier, bu metal olmayan elementi 1777'de tanımlamıştır. Katı kükürt sarı, kırılgan, kokusuz, tatsızdır ve suda çözünmez. "Tiyol" terimi kükürt içeren bileşikleri ifade eder. Kükürt, periyodik tablonun 16. grubunun elementleri olan kalkojenlere aittir ve çeşitli redoks durumları ve redoks potansiyellerine sahip olma gibi harika bir özellik gösterir ve bu da onların interkalkojen bağları ve atom değişim reaksiyonları oluşturmalarına olanak tanır ve biyolojik süreçlerde yer alan çok sayıda kükürt türünün ortaya çıkmasına neden olur (Şekil 1).

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bir antidepresan görevi görebilir. SAM, ruh halini değiştirilebildiğinin gösterildiği depresyon çalışmalarında geleneksel antidepresan ilaçlar kadar iyi performans göstermiştir. SAM ayrıca, membran fosfolipidlerinin sentezlendiği transmetilasyon reaksiyonlarında bir metil grubu donörü olarak temel bir role sahiptir ve membran akışkanlığının korunması için zorunludur. SAM'yi içeren bir diğer metabolik yol olan trans-sülfürasyon, molekülden bir metil grubunun salınması ve önce homosisteine, sonra glutatyonun bir öncüsü olan sisteine dönüştürülen S-adenozil-homosistein oluşumuyla başlatılır (45). Deneysel araştırmalar, SAM uygulamasının analjezik etkiler gösterdiğini ve eklem kondrositleri tarafından proteoglikanların sentezini uyardığını, gastrointestinal sistem ve diğer organlar üzerinde minimum veya hiç yan etki olmadığını ileri sürmektedir (46). SAM'nin osteoartrit üzerindeki etkisi non-steroidal antiinflamatuar ilaçların (NSAID'lerin) etkisine benzerdir, ancak daha iyi tolere edilir. NSAID'lerin normal farmakolojik konsantrasyonlarda, insan eklem kıkırdağında glikozaminoglikan sentezini inhibe ettiği, ayrıca gastrointestinal kanamaya ve böbrek sorunlarına neden olduğu gösterilmiştir. NSAID'lerin romatizmal ağrı için kullanımıyla ilişkili yan etkiler nedeniyle, SAM güvenli bir alternatif olarak kullanılabilir. Etanol ile beslenen babunlarda, SAM glutatyon seviyelerinin azalmasını önler, mitokondriyal enzimleri normalleştirir ve hepatik lezyonların histolojik iyileşmesiyle sonuçlanır. Sağlıklı insan gönüllülerde, etanol alımından sonra SAM'nin plazma etanol ve asetaldehit konsantrasyonunu önemli ölçüde düşürdüğü gösterilmiştir. Mato ve arkadaşları tarafından yapılan iki yıllık çift kör bir çalışmada, SAM alkolik sirozlu hastalarda test edilmiştir (47). Kontrollerle karşılaştırıldığında %47 daha düşük ölüm oranı veya karaciğer nakli ihtiyacı kaydedilmiştir. Hastalar günde 1.200 mg SAM almışlardır. Daha az şiddetli sirozu olan kişilerde sonuçlar daha da etkileyiciydi. SAM ayrıca, parasetamol aşırı dozundan sonra geç başvuran hastalarda N-asetilsisteine bir alternatif olarak önerilmiştir.

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BÖLÜM 11

KLOR

Ceyhan HACIOĞLU[1]

Giriş

Klor (Cl), sodyumdan sonra insanlarda en bol bulunan iyondur ve ekstraselüler sıvıdaki (ECF) toplam anyonların %70'ini oluşturur. Bir yetişkinin vücudunda yaklaşık 115 gram klor bulunur ve bu, vücut ağırlığının %0,15'ine denk gelir (Şekil 1). Klorür (Cl^-), vücuttaki ozmotik basıncı, kas hareketini ve asit-baz dengesini korumak için hayati öneme sahiptir. Cl^- homeostazı, genellikle göz ardı edilir, ancak hücrenin içinde ve dışında çeşitli önemli fizyolojik işlevleri yönettiği bilinmektedir (1). Katyonlarla birlikte Cl^-, iyonik homeostazın, ozmotik basıncın ve asit-baz dengesinin korunmasından sorumludur. Bu nedenle, Cl^- seviyelerindeki bozukluklar, hipokloremik metabolik alkaloz ve hiperkloremik metabolik asidoz dahil olmak üzere metabolik bozuklukların göstergesidir. Cl^-, çoğu memeli hücresinde elektrokimyasal dengeyi takip etmez. Birincil duyusal nöronlar, lökositler, epitel, sempatik ganglion ve kas hücreleri dahil olmak üzere birçok hücrede, hücre içi Cl^- denge seviyelerinin üzerinde tutulur (Şekil 2). Cl^-'nin taşınması, kimyasal ve elektriksel gradyanları kullanan kanallar, değiştiriciler ve yardımcı taşıyıcılar aracılığıyla gerçekleşir (2).

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alkaloza neden olabilse de, Cl^- replesyonu (NaCl veya KCl formunda) hacim kaybı devam etse dahi metabolik alkalozu düzeltecektir. Cl^- tükenmesi kortikal toplayıcı kanalda HCO_3^- salgılanmasını önler ve dış medüller toplayıcı kanalda artan HCO_3^- geri emilimi Cl^-'ye yanıt veren alkalozu korur. Cl^- uygulaması, toplayıcı kanala Cl^- iletimini artıracak ve salgılanmasını artırarak ve geri emilimini azaltarak idrar HCO_3^- atılımını artıracaktır. Cl^- dirençli metabolik alkaloz, büyük ölçüde mutlak veya belirgin mineralokortikoid fazlalığı ile işaretlenen sendromları etkiler, ancak telafi edici renal klorür tutulumunu devre dışı bırakan aktif diüretik kullanımı önemli bir istisnadır (29).

Hiperkloremi

Referans aralığının (97−107 mmol/L) üzerinde bir serum Cl^- konsantrasyonu olarak tanımlanan hiperkloremi, genellikle şiddetli ishal (metabolik asidoz) nedeniyle dışkıda bikarbonat kaybından kaynaklanır. Hiperkloremi, anormal su kayıpları (deri, böbrek veya böbrek dışı), hücre dışı sıvı hacmi azalması veya tübüler klorür reabsorbsiyonunda artışla ilişkili birkaç başka durumla birlikte ortaya çıkabilir. Ayrıca aşırı tuz alımının (örn. NaCl, NH_4Cl, $CaCl_2$) veya belirli ilaçların (örn. kortizon preparatları, asetazolamid) alımının sonucu da olabilir. Yetersiz veri nedeniyle Cl^- için tolere edilebilir bir üst alım seviyesi belirlenememiştir, ancak Avrupa toplumları arasında mevcut alım seviyelerinin normal işlev için gereken miktarları aştığını ve NaCI gibi Cl^- artan alımının, kardiyovasküler ve böbrek hastalıklarına yol açabilen yüksek kan basıncı olasılığıyla ilişkilendirildiğini belirtmiştir (30).

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BÖLÜM 12

MAGNEZYUM, SODYUM, POTASYUM

Canan ALTINSOY[1]
Çiler ÖZENİR[2]

MAGNEZYUM

Mineralin genel tanımı ve organizmadaki dağılımı

Magnezyum (Mg^{+2}), vücutta en bol bulunan dördüncü katyondur. Hücre içinde ise potasyumdan sonra en bol bulunan ikinci katyondur. Yetişkin bir insan vücudu (70 kg) 21 ila 28 gram magnezyum içerir. Magnezyumun yaklaşık %60'ı kemiklerde, %20'si iskelet kasında, %19'u diğer hücrelerde ve yaklaşık %1'i hücre dışı sıvıda bulunur (1, 2) (Şekil 1).

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Mineralin gereksinmesi ve kaynakları

TÜBER'e göre potasyum için yeterli alım miktarı yetişkin bireyler ve gebeler için 4700 mg/gün, emziklilik dönemi için 5100 mg/gün'dür. Potasyumun zengin kaynakları arasında kurubaklagiller, tam tahıllar, turunçgiller, muz, avokado, yeşil yapraklı sebzeler, patates, et ve kuruyemişler yer almaktadır (67).

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BÖLÜM 13

MİKRO MİNERALLER VE ORGANİZMADAKİ GÖREVLERİ

Hüseyin ESECELİ[1]

Giriş

Homeostaz (homeostasis) veya dengeleşim, çevresinde gerçekleşen olumsuzluklar karşısında hücrenin kendi dengelerini koruma çabası, değişen koşullarda iç dengenin aktif düzenlemesidir. Mikro mineraller, bir organizmanın sağlıklı durumunun sürdürülmesinde önemli bir rol oynar. Mikro mineral homeostazındaki bozukluklar patolojik durumların ve hastalıkların gelişmesine neden olabilir.

İnsan ve hayvan organizmalarında tespit edilebilen çok sayıda kimyasal elementten yaklaşık 26'sının hayat için önemli olduğu kabul edilmektedir. Bu elementlerin fizyolojik fonksiyonları henüz tam olarak bilinmemekle birlikte, her geçen gün yeni elementler bu listeye eklenmektedir.

İNSAN SAĞLIĞI İÇİN GEREKLİ MİKRO MİNERALLER:

Mikro mineraller, vücut ağırlığının %0.01'inden daha azını oluşturan, günlük gereksinimi 100 mg'dan az olan ve milyonda bir veya daha düşük konsantrasyonlarda ihtiyaç duyulan minerallerdir. İlk analitik yöntemlerle dokulardaki düşük konsantrasyonları kolayca ölçülemediği için bu mineraller başlangıçta "İz mineraller" veya "Eser elementler" (diğer adıyla minör elementler, oligoelementler, veya katalitik elementler) olarak adlandırılmıştır.

İz mineral/Eser element, çok küçük miktarlarda bulunan ve organizmaların

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bilimsel araştırmaların daha derin ve daha küresel planlanmasını ortaya koyacaktır. Ayrıca, hastalıkların önlenmesi ve tedavisine ilişkin paradigmanın temelde semptomatik olmaktan çıkarılıp, beslenme ve farmakoterapide biyoelement kaynaklarının kullanımı yoluyla biyoelement dengesinin önlenmesi ve normalleştirilmesine yönelik temellere dönüştürülmesi gerekmektedir.

Biyoelementolojik yaklaşımın geliştirilmesi, sağlık durumunun bütünleştirici teşhisinin oluşturulmasında ve basit birincil biyoelementler olarak temel iz mineralleri içeren "yaşam blokları" ile insanların beslenmesinde yeni perspektifler açabilir ve biyoelementlerin etiyolojik dengesizliğinde gerçek kişiselleştirilmiş beslenme ve hastalıkların tedavisini sağlayabilir.

Ayrıca, iz minerallerin insan beslenmesindeki önemi ve enzimler, anti-oksidanlar, vitaminler gibi canlı organizmaların hayatta kalması için gerekli diğer hayati faktörleri etkileyen metabolik karşılıklı ilişkileri göz önüne alındığında, suyun ve sırasıyla baklagiller, tahıllar, meyveler ve sebzeler gibi insan ve hayvan gıdaları ve yemleri için yaygın olarak tüketilen çeşitli bitkisel gıdaların mineral içeriği hakkında düzenli olarak güncel bilgi edinmek önemlidir. Bunun nedeni pestisit, herbisit, gübre gibi kimyasalların bu bitkilerin yetiştirildiği toprakların mineral içerikleri üzerindeki etkileridir. Genetik, konum ve çevresel faktörler de bitkilerdeki mineral element seviyelerini etkileyebilir.

Mineraller arasındaki etkileşimleri, örneğin silisyum, alüminyum ve bakır arasındaki etkileşimi ortaya çıkarmak için daha fazla araştırma yapılması gerekmektedir. Farklı işleme yöntemlerinin su ve bitkisel gıdaların mineral içeriği üzerindeki etkilerinin de değerlendirilmesi gerekmektedir. Bu, yetersiz gıda tedariki, dengesiz diyet tüketimi ve yetersiz beslenme eğitiminden kaynaklanan yetersiz beslenme sorununu azaltmada uzun bir yol kat edecektir.

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