STIVIYA VA INULIN ASOSIDAGI DESERTLAR RETSEPTURASINI LOYIHALASH: SHIRINLIK EKVIVALENTI, XAVFSIZLIK CHEGARALARI VA ENERGIYA QIYMATINI HISOBLASH

Xalilov Shuhrat Uralovich
Toshkent kimyo-texnologiya instituti assistenti, Toshkent, O'zbekiston
E-mail: iforzod@gmail.com · ORCID: 0009-0007-7308-4190
https://doi.org/10.5281/zenodo.23167868

Kalit so'zlar: rebaudiozid A, inulin, chia, retseptura, joiz sutkalik iste'mol, energiya qiymati, parhez tolasi.

Kirish

Shakari kamaytirilgan desert yaratayotgan texnolog uchta savolga javob topishi kerak: olib tashlangan saxaroza shirinligini qancha shirinlashtiruvchi bilan qoplash mumkin, bu miqdor turli yoshdagi iste'molchilar uchun xavfsizmi va mahsulotning energiya hamda ozuqaviy qiymati qanday o'zgaradi. JSST qo'shilgan shakarni kamaytirishni tavsiya etar ekan [1], bu savollarga laboratoriya tajribasidan oldin hisob yo'li bilan javob olish tajriba rejasini aniqroq tuzish va xomashyoni tejash imkonini beradi.

Maqsad

Stiviya (rebaudiozid A) va inulin asosidagi desertlar retsepturasini loyihalash uchun shirinlik ekvivalenti, xavfsizlik chegarasi, energiya qiymati va parhez tolasini hisoblash apparatini ishlab chiqish.

Tadqiqot metodlari

Tadqiqotda nazariy tahlil va hisob-analitik modellashtirish usullari qo'llanildi. Hisoblashda rebaudiozid A ning nisbiy shirinlik koeffitsiyenti K = 125–380 va steviol ekvivalentiga o'tkazish koeffitsiyenti 0,33 [2], EFSA belgilagan joiz sutkalik iste'mol[1] – tana vaznining har kilogrammiga 4 mg [3], energiya koeffitsiyentlari – uglevodlar uchun 4 kkal/g, parhez tolasi uchun 2 kkal/g [4] qabul qilindi. Rebaudiozid A massasi (mg), steviol ekvivalenti (SE) va ADI ulushi hamda almashtirilgan qism energiyasi (kkal) quyidagi formulalar bilan topildi:

$$m_{RA} = 1000 \cdot m_S / K, \quad (1)$$

$$SE = 0{,}33 \cdot m_{RA}; \quad \text{ADI ulushi} = SE / (4 \cdot BW) \cdot 100, \quad (2)$$

$$E = 4 \cdot m_S + 2 \cdot m_I, \quad (3)$$

bu yerda m_S va m_I – saxaroza va inulin massasi, g; BW – tana vazni, kg. Hisoblar 10 g saxaroza, 20, 40 va 70 kg tana vazni hamda 185 g lik chia-desert nazariy model parametrlari sifatida olinib bajarildi[2]. Olib tashlangan saxaroza massasi inulin bilan teng massada almashtiriladi deb qabul qilindi; bu nazariy modelning farazi hisoblanadi.

---

[1]Joiz sutkalik iste'mol (ADI) – inson umri davomida har kuni qabul qilganda sog'lig'iga sezilarli xavf tug'dirmaydigan miqdor; steviol glikozidlari uchun steviol ekvivalentida ifodalanadi.

[2]Model parametrlari muayyan mahsulotning haqiqiy tarkibini ifodalamaydi; aniq retseptura ma'lum bo'lganda hisob shu formulalar bilan qayta bajariladi.

© Ushbu material Creative Commons Attribution 4.0 International (CC BY 4.0) litsenziyasi asosida tarqatiladi.

Natijalar

10 g saxarozani almashtirish uchun shirinlik koeffitsiyentiga qarab 26,3 mg dan 80,0 mg gacha rebaudiozid A talab etiladi. Uning steviol ekvivalentidagi ulushi 1-jadvalda keltirilgan.

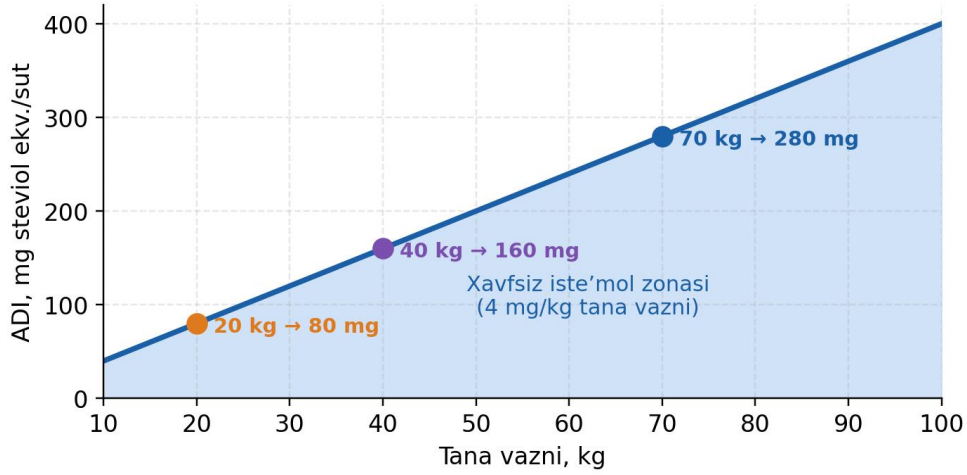
1-jadval

10 g saxarozani almashtirishda steviol ekvivalentining ADI dagi ulushi, %

K	m_{RA}, mg	Bola, 20 kg	O'smir, 40 kg	Katta yoshli, 70 kg
125	80,0	33,0	16,5	9,4
250	40,0	16,5	8,3	4,7
380	26,3	10,9	5,4	3,1

Manba: (1)–(2) formulalar bo'yicha muallif hisobi

Kattalar uchun bitta almashtirish ADI ning 10 foizidan kamini tashkil etadi, 20 kg vaznli bola uchun esa bu ulush 33 foizgacha yetadi. ADI ning tana vazniga chiziqli bog'liqligi 1-rasmda ko'rsatilgan.

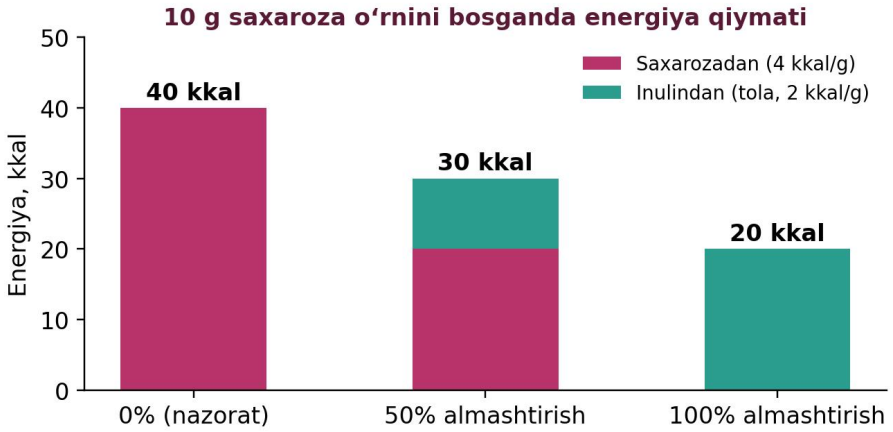


1-rasm. Steviol glikozidlari uchun joiz sutkalik iste'molning tana vazniga bog'liqligi

Manba: EFSA me'yori [3] asosida muallif tomonidan tuzilgan

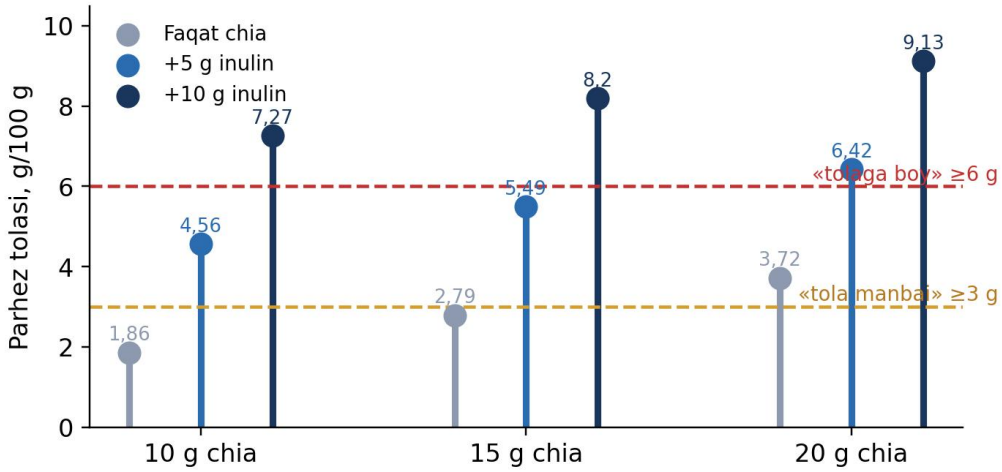
(3) formulaga ko'ra, saxarozaning yarmi inulin bilan teng massada almashtirilganda almashtirilgan qism energiyasi 40 kkal dan 30 kkal gacha (−25 %), to'liq almashtirilganda 20 kkal gacha (−50 %) kamayadi. Bunda porsiyaga 5–10 g tola qo'shiladi, bu klinik sinovda qo'llangan kunlik 15 g dozaning [5] uchdan bir yoki uchdan ikki qismiga teng.

© Ushbu material Creative Commons Attribution 4.0 International (CC BY 4.0) litsenziyasi asosida tarqatiladi.



2-rasm. 10 g saxarozani inulin bilan almashtirishda energiya qiymatining o'zgarishi
Manba: (3) formula va [4] koeffitsiyentlari asosida muallif hisobi

Parhez tolasi hisobida 100 g chia urug'idagi 34,4 g tola [6] asos qilib olindi. Natijalar 3-rasmda Yevropa Ittifoqining «tola manbai» (≥3 g/100 g) va «tolaga boy» (≥6 g/100 g) mezonlari bilan solishtirilgan [7]. Porsiyada 20 g chia bo'lsa yoki 10 g chiaga 5 g inulin qo'shilsa, desert «tola manbai» mezoniga javob beradi.



3-rasm. 185 g chia-desertda parhez tolasining hisobiy miqdori, g/100 g
Manba: [6; 7] ma'lumotlari asosida muallif hisobi

Hisob natijalarini talqin qilishda rebaudiozid A shirinligi doimiy emasligini hisobga olish zarur: DLG ma'lumotiga ko'ra, u taqqoslanayotgan saxaroza eritmasining konsentratsiyasiga bog'liq ravishda o'zgaradi [2]. Shuning uchun 1-jadvaldagi oraliq yakuniy doza emas, balki sensor titrlash uchun chegaradir. Titrlashda oraliqning quyi, o'rta va yuqori nuqtalarida (26, 40 va 80 mg/10 g saxaroza) namunalar tayyorlanadi va iste'molchilar guruhi ularning shirinligini nazorat namunasi bilan solishtiradi. Shirinligi nazoratga eng yaqin, achchiq ta'm qoldig'i sezilmaydigan doza maqbul deb qabul qilinadi. Stiviyaning milligramm miqdorlari energiya balansiga amalda ta'sir ko'rsatmaydi, shuning uchun energiya hisobi faqat saxaroza va inulinni o'z ichiga oladi.

© Ushbu material Creative Commons Attribution 4.0 International (CC BY 4.0) litsenziyasi asosida tarqatiladi.

Xulosa

Taklif etilgan hisob apparati stiviya dozasini 26–80 mg/10 g saxaroza oralig'i bilan cheklaydi, yakuniy doza esa sensor titrlash orqali aniqlanishi lozim. Bolalar iste'molini hisobga olib, porsiyadagi steviol ekvivalenti yorliqda ko'rsatilishi kerak. Inulin ham energiya bergani uchun mahsulotning asosiy afzalligi kaloriya kamayishida emas, balki qo'shilgan shakar kamayishi va tola ortishida namoyon bo'ladi. Bu JSST ning shakarsiz shirinlashtiruvchilarni vazn nazorati vositasi sifatida tavsiya etmaydigan 2023-yilgi yondashuviga ham mos keladi [8].

Foydalanilgan adabiyotlar

1. World Health Organization. Guideline: Sugars intake for adults and children. – Geneva: WHO, 2015. – 49 p.
2. DLG e.V. Steviol glycosides. DLG Expert report 14/2015. – Frankfurt am Main: DLG, 2015.
3. EFSA Panel on Food Additives and Nutrient Sources added to Food (ANS). Scientific Opinion on the safety of steviol glycosides for the proposed uses as a food additive // EFSA Journal. – 2010. – Vol. 8, No. 4. – Art. 1537. DOI: 10.2903/j.efsa.2010.1537.
4. Regulation (EU) No 1169/2011 of the European Parliament and of the Council on the provision of food information to consumers. Annex XIV. – Official Journal of the European Union, 2011.
5. Li J., Liu F., Luo Y. et al. Differential effects of inulin and fructooligosaccharides on gut microbiota composition and glycemic metabolism in overweight/obese and healthy individuals: a randomized, double-blind clinical trial // BMC Medicine. – 2025. – Vol. 23. – Art. 372. DOI: 10.1186/s12916-025-04189-6.
6. U.S. Department of Agriculture, Agricultural Research Service. FoodData Central: Seeds, chia seeds, dried (FDC ID 170554). URL: https://fdc.nal.usda.gov/
7. Regulation (EC) No 1924/2006 of the European Parliament and of the Council on nutrition and health claims made on foods. Annex. – Official Journal of the European Union, 2006.
8. World Health Organization. Use of non-sugar sweeteners: WHO guideline. – Geneva: WHO, 2023.

© Ushbu material Creative Commons Attribution 4.0 International (CC BY 4.0) litsenziyasi asosida tarqatiladi.