POTASSIUM AND HUMAN HEALTH

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Potassium (K) Biological Functions

- Major intracellular cation.
- Resting cellular-membrane potential and the propagation of action potentials in neuronal, muscular, and cardiac tissue.
- Fluid balance and electrolyte regulation.
- Acid-base balance.
- Enzyme activities.
Rich dietary sources of potassium (per portion) include:

- Baked sweet potato (694 mg)
- Baked white potato (flesh) (610 mg)
  - Yogurt (579 mg)
  - Prune juice (530 mg)
  - Carrot juice (517 mg)
  - Tuna (484 mg)
- Winter squash (448 mg)
  - Banana (422 mg)
  - Spinach (419 mg)
- Tomato juice (417 mg)

Assessing Potassium Intake Needs

Risk of Inadequacy

1.0

EAR

RDA

UL

Risk of Excess

1.0

0.5

0.0

0.5

0.0

Increasing Intake

National Academy of Sciences, 2017

EAR: Estimated Average Requirement.

RDA: Recommended Dietary Allowance.

UL: Tolerable Upper Intake Level.

AI: Adequate Intake.
Potassium is a Short Fall Nutrient

Adequate Intake (AI) is 4700 mg/d.

Only 3% of Americans meet the recommended intake.

Similar in Europe.

Physiological Roles of K

- **Heart and Vasculature**
- **Kidneys**
- **Bone**
Approximately 90% of K consumed is lost in the urine, 10% excreted in the stool, small amount lost in sweat.

Only 2% of the total body K is distributed in ECF, with the remaining in the ICF/tissues.

Potassium homeostasis is primarily modulated by the kidneys.
Renal K Handling

High intakes of K are associated with a reduction in recurrent kidney stones.

Dietary K may slow the progression of kidney disease.

- High K intake improves glomerular function, tubular flow, and decreases nephron loss in hypertensive rats.

Koeppe & Stanton: Barne and Levy Physiology, 6th Edition. Copyright © 2008 by Mosby, an imprint of Elsevier, Inc. All rights reserved.

Little is known about the bioavailability of K.

Assessment of urinary K losses after potassium salt supplementation in males.

Early Compartment models.

Clinical Study: 35 normotensive men and women (20-60y): RCT, cross-over:
• 9 interventions: 0mg, 720mg, 1440mg, 2160mg K/d as K-glucconate or potato.

Results:
Serum K AUC increased with dose (p<0.0001) and did not differ due to source.

Cumulative 24 hour urinary K also increased with dose (p<0.0001) and was greater with potato than supplement.
K Intake and Heart/Vascular Health

Potassium (in conjunction with Sodium) affects the balance of fluids in the body.

Hypertension (HTN) is the leading cause of cardiovascular disease (CVD) and major risk factor for:
- Stroke
- Coronary heart disease
- Heart attack
- Heart failure
- Kidney disease

Worldwide, HTN is estimated to cause **7.5 million deaths/year**, about **12.8%** of the total of all deaths.

He and McGregor, BMJ, 2001;323:497–501
K Supplementation Moderately Decreases BP

Meta-analyses: a dose–response between K intake and BP lowering.

Doses of K in the range of 1900 to 4700 mg/d (49–122 mmol/d) resulted in BP lowering of approximately 2-6mmHg SBP and 2-4mmHg DBP.

*Pretreatment BP, age, race, comorbidities, intake of other ions, diet, exercise, weight, type of K used, medications, duration.
Limited K Dietary Interventions Show Mixed Results

Chamlers et al (1986): RCT, parallel design: 212 HTN subjects (52.3 +/- 0.8 y; 181 m, 31 f):
12 week diet → normal, high-K (>100 mmol K/d), reduced-Na (50-75 mmol Na/d), high-K and low-Na.

Results: K → SBP: -7.7, DBP: -4.7. (p <0.005).

Berry et al. (2010): RCT, cross-over: HTN 48 (23m/25f, 22-66y):
Four 6-week interventions → (control, 20 or 40 mmol K/d from fruit and vegetables, or 40 mmol K-citrate/d)

Results: No significant differences.

Primary limitation in both studies →
Lack of a controlled diet.

Chamlers et al., Journal of Hypertension, 1986, 4 (suppl 6): S629-S637;
DASH Trails and K

Dietary Approaches to Stop Hypertension (DASH): controlled feeding study conducted at 4 medical centers

Subgroup analysis (N=459):

Subjects randomized to 1 of 3 diets for 8wks:
• control
• high fruit/vegetables (~4000mg K/d)
• high fruit/vegetables and low fat (combination diet).

Results: the combination diet and fruit/vegetable diet significantly lowered BP.

Adequate K Intake May Benefit Bone

Osteoporosis: loss of bone mass with age leading to bone fragility/fracture.
- >9 million fractures/year worldwide, cost ~$100 billion.

K intake may influence acid-base balance, which can affect bone health.
- Diets high in protein/cereal grains promote aciduria and hypercalciuria.

Increases in dietary K may result in decreases in urinary calcium excretion and bone turnover, and increases in bone mineral density (BMD).
BMD Benefit May be Dose/Form Dependent

Parallel design: randomized, double-blind, placebo-controlled trial.

Subjects: 201 elderly (≥65y) healthy men and women.
- Intervention: 60 mEq of K-citrate/d or placebo.

Primary outcome: %BMD change in lumbar spine (L₂-L₄) over 2 years.

Results:

- K-citrate increased spine BMD by 1.7%.
- Also increased hip and total body BMD by 1.6 and 1.3%, respectively.

Jehle et al, J Clin Endocrinol Metab, 2013;98:207–17
Physiological Roles of K

May improve BP, decreases CVD related outcomes.

Normal function, decrease kidney stones, may slow kidney disease.

Decrease urinary Ca loss, bone turnover, improve BMD.
Questions for Agronomists

• To what extent can the potassium content of a food be manipulated?

• What vegetables should receive priority for studies examining K absorption by humans?
  • Regional and cultural preferences?

• Could manipulating the mineral content of foods effect consumer acceptability?
  • Taste, texture, etc.
Questions?