K2VITAL®
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Kappa BIOSCIENCE

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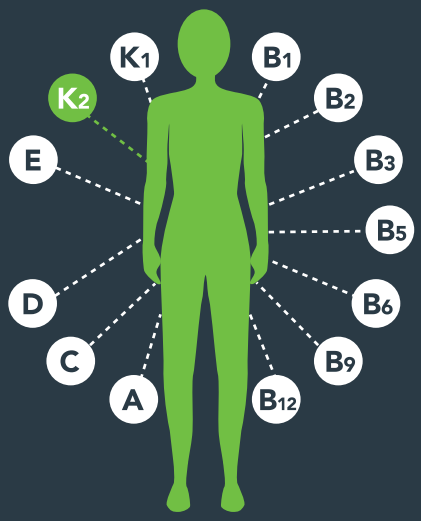
INTRODUCTION

VITAMIN K2 IS AN ESSENTIAL FAT-SOLUBLE VITAMIN



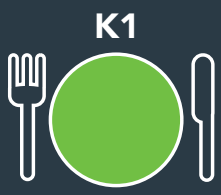
Like all vitamins, it must be obtained from the diet to enable your body to function as it should.

VITAMIN K2 DIRECTS CALCIUM TO THE RIGHT PLACES

K2 MK-7 helps bind calcium into bones for strong bone development and directs free calcium away from the arteries to maintain healthy circulation.

TODAY OUR DIETS DO NOT PROVIDE ENOUGH VITAMIN K2

100%
Average vitamin content in a balanced diet



25%
Minimum recommended intake 75 µg

Vitamin K2 (as well as D3) needs to be supplemented in the diet.

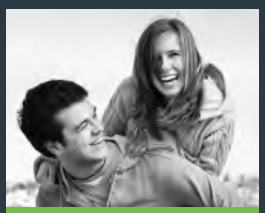
VITAMIN K2 MK-7 IS THE BEST FORM OF VITAMIN K

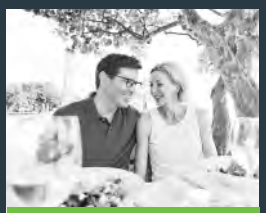
K2 MK-7 exhibits the best bioavailability and longest half-life among all K vitamins.

K2 MK-7 efficiently activates:
- Osteocalcin for bone building
- Matrix Gla protein for arterial decalcification

BONE AND TEETH


CHILDREN & ADOLESCENTS


EARLY ADULTHOOD AGE 20-40


ACTIVE LIFESTYLES AGE 40-60+


SENIOR YEARS

HEART

VITAMIN K2 BENEFITS ALL CONSUMERS REGARDLESS OF AGE, LIFE-STAGE OR GENDER.

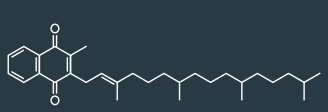
THE VITAMIN K FAMILY

VITAMIN K1
Vitamin K1 (phylloquinone) accounts for 90% of total vitamin K intake.

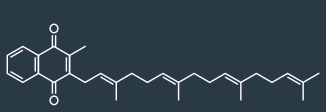
K2 DEFICIENCY
Western diets are deficient in vitamin K2. Especially, Vitamin K2 as menaquinone-7 needs to be supplemented.

VITAMIN K2 MK-7
With a half-life of about 72 hours, MK-7 remains biologically active in the body longer than any other form of vitamin K.

K1, K2 MK-4 or K2 MK-7:
WHICH K VITAMIN WORKS BEST FOR BONE AND HEART HEALTH?



Vitamin K1
Phylloquinone



Vitamin K2 MK-4
Menaquinone-4

VITAMIN K2 MK-7
Menaquinone-7

THE VITAMIN K FAMILY FACTS

K1

Sources
Green leafy vegetables

Half-life
1-2 hours

Dietary contribution to vitamin K activity
- Major vitamin K intake (>90%)
- Low bioavailability (<20%)
- Less active than K2 MK-7

Function
Mainly supports blood coagulation

K2 MK-4

Sources
Animal products

Half-life
1-2 hours

Dietary contribution to vitamin K activity
- Minor vitamin K intake
- Less active than K2 MK-7

Function
MK-4 promotes bone and heart health

K2 MK-7

Sources
Fermented food (natto, certain cheeses)

Half-life
72 hours

Dietary contribution to vitamin K activity
- Minor vitamin K intake
- Provides the highest vitamin K activity

Function
MK-7 promotes bone and heart health

K2 TRANSPORTATION
Due to the large difference in uptake and half-lives, MK-7 reaches bones and vessel walls more easily, resulting in more effective activation of osteocalcin and MGP.

INTAKE
Only 75 µg to 120 µg of MK-7 once a day meets the daily requirements.

THE NEW STANDARD
The market has adopted MK-7 as the standard for dietary supplementation.

THE CHOICE
The superior bioavailability of MK-7 has made it the K vitamin of choice. Consumer research data confirms consumer preferences for K2 as MK-7.

K2VITAL®

K2VITAL® is 100% pure MK-7 and is, therefore, one of the best supplements to combat K2 deficiency regardless of age and life-stage or gender.

THE HISTORY OF VITAMIN K

TIMELINE OVERVIEW – DISCOVERY AND REDISCOVERY OF VITAMIN K2

1600s – Japanese warriors consumed **K2**-rich fermented soybeans - natto

1930s – Dam discovered a fat-soluble substance that reduced bleeding; Doisy determined the chemical structure of vitamin K and succeeded in synthesizing it

1943 – Dam and Doisy shared the Nobel Prize in Medicine for the discovery of vitamin K family.

1950s – Price first described a crucial molecule was involved in bone and teeth health, which he named 'Activator X', later identified as being **K2**.

1960s – **K2** as MK-4 became an approved drug in Japan

1970s – Vermeer started scientific work on enzymes and coagulation

1990s – Motohara *et al.* studied the transfer of **K2** between mothers and newborns

2000s – Studies investigating **K2** and bone health as well as **K2** biomarkers

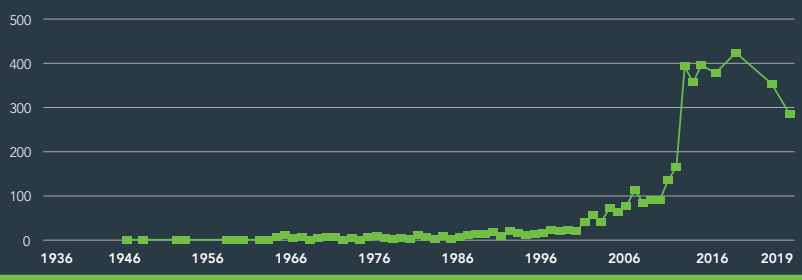
2015 – Knapen *et al.* and Kurnatowska *et al.* demonstrated **K2**'s effect on reducing cardiovascular risk

2016 – Møller *et al.* demonstrated that synthetic **K2** (K2VITAL®), and fermented **K2** are biologically equivalent

2020 – Synthesis dominant production method. Critical Quad solved. Mass markets open

PUBMED RESULTS SHOWING A SPIKE IN K2 PUBLICATIONS IN THE LAST DECADE

Vitamin K2-PubMed Results by Year



KAPPA BIOSCIENCE AND VITAMIN K2

2000s

Kappa Bioscience invented the synthesis of K2 MK-7, filed its patents and regulatory approvals in the USA, EU and Australia.

2009

Two Norwegian scientists, Inger Reidun Aukrust, Ph.D., and Marcel Sandberg, Ph.D., achieved the first laboratory synthesis of the MK-7 molecule. **Kappa Bioscience, and the K2 MK-7 market, were born.**

2010

Kappa Bioscience launched the **K2VITAL®** product range covering K2 MK-7 powders, oils and microencapsulated powders.

2011

Kappa discovered that standard, unprotected K2 is not stable in some formulations, particularly with minerals.

2012

Kappa solved the stability issue with minerals with microencapsulation. In 2012 **K2VITAL® DELTA** was launched. These years also saw the development of several analytical methods to ensure product quality, including the publication of the **DELTA** method for analyzing encapsulated K2 in the official MK-7 monograph.

2019

Kappa becomes the global market share leader in K2.

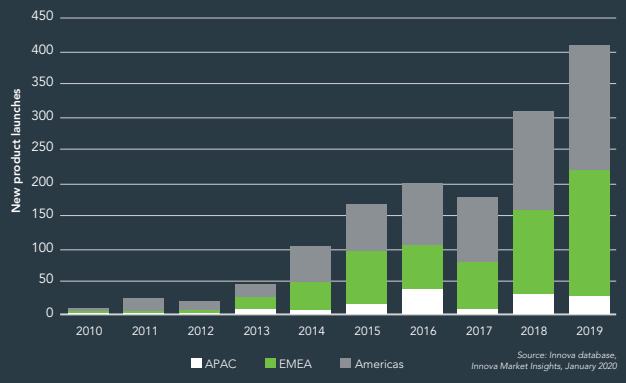
2020

Vitamin K2 succeeds in moving mainstream in supplements and, with expanded approvals from health authorities, K2VITAL® products are now available to consumers all around the globe. **Global retail sales have surpassed $1 bn USD.**

K2VITAL®

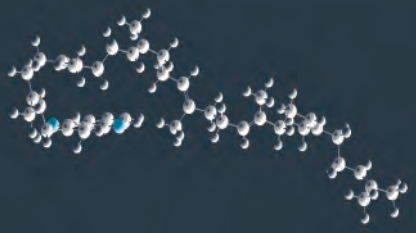
K2 RETAIL LAUNCHES

(Globally 2010 - 2019)



ALL-TRANS K2 MK-7

THE SUPERIOR K2 MK-7



ALL-*TRANS* VS. *CIS* ISOMERS: DIFFERENT BIOLOGICAL ACTIVITIES

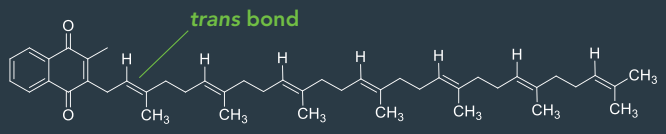
ALL-*TRANS* MK-7

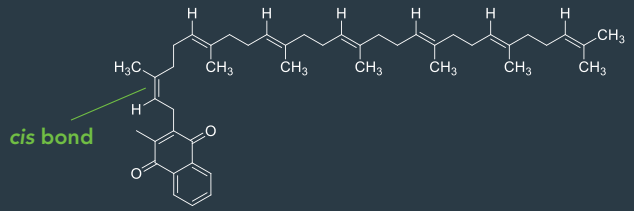
- The menaquinones found in nature exist in an all-*trans* configuration.
- Menaquinones in all-*trans* configuration have an extended system of isoprenoid units and are consequently linear.
- *Trans* is the bioactive form of the molecule.

VS

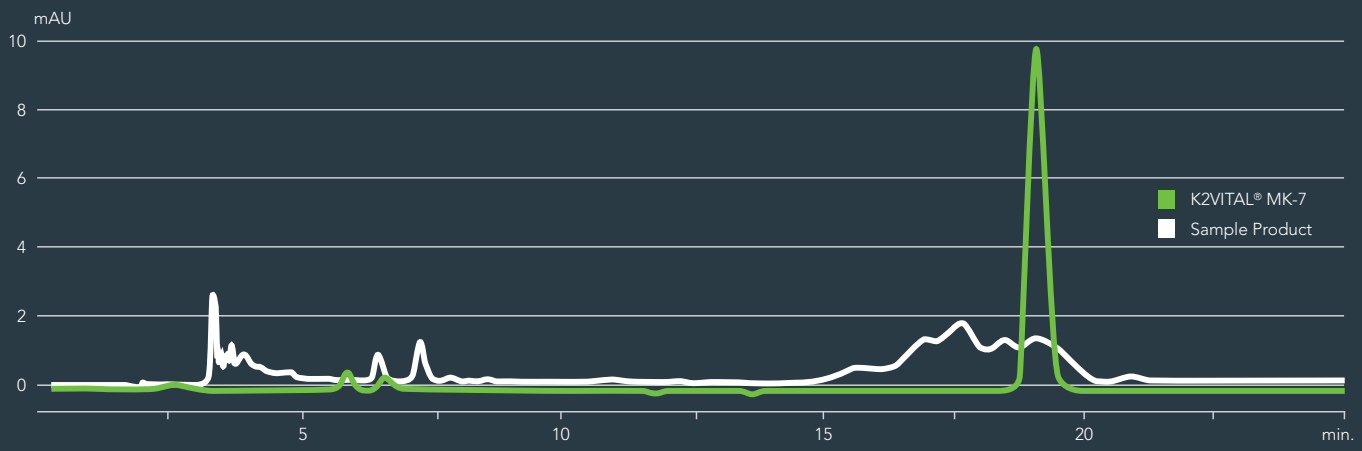
CIS MK-7

Through the number of double bonds, many geometric isomers (*cis* isomers) are theoretically possible. The *cis* isomers are not linear, and their shape differs substantially from that of the all-*trans* form. Because of this, *cis* isomers may not fit where they are supposed to, leaving K2-dependent enzymes and proteins inactivated. *Cis* isomers may have reduced activity or be biologically inactive.





CHROMATOGRAM – PURE K2VITAL® K2 MK-7 COMPARED TO LOW QUALITY MK-7:
Isomeric Purity



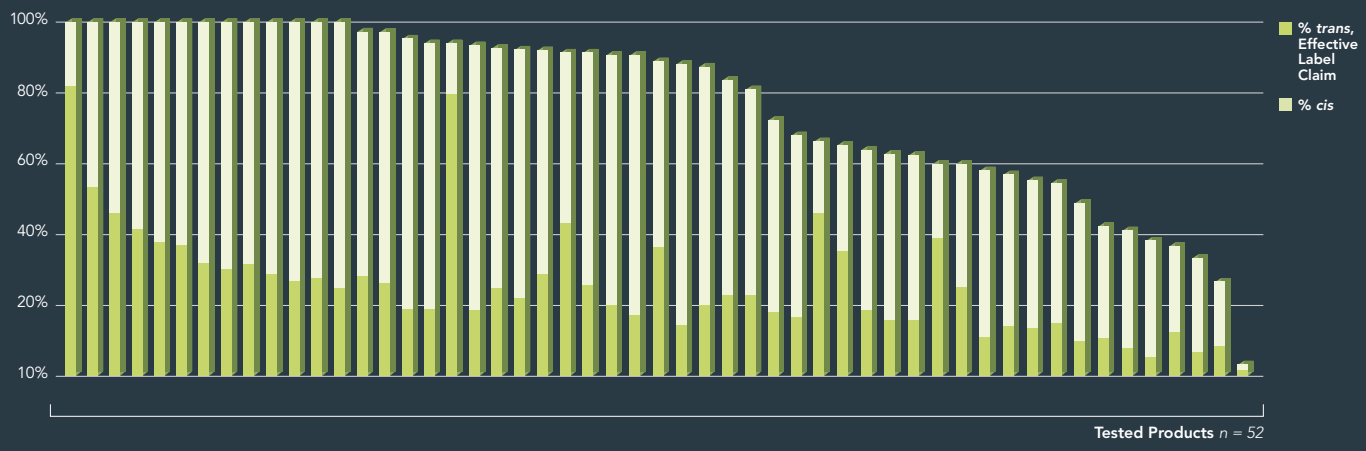
LOW QUALITY *CIS* PRODUCTS
The USP monograph does not require *cis* vs. *trans* determination in finished supplements. This allows low-quality products to enter the market and under-perform in K2 efficacy.

K2VITAL®
99.7%
PURE *trans* MK-7

The United States Pharmacopeia (USP), requires K2 ingredients and preparations to be at least 96% *trans* MK-7 isomers. K2VITAL® exceeds these purity requirements with a 99,7% *trans* MK-7.

INACTIVE *CIS* PRODUCTS
Consumer product testing studies repeated over several years consistently demonstrate unacceptably high numbers of biologically inactive *cis* MK-7 products sold to consumers *(1)*.

EFFECTIVE LABEL CLAIM: K2 PRODUCTS
Result Label Claim including *cis*/inactive MK-7 %



REFERENCE: *1. Szterk, A., A. Zmyslowski, and K. Bus, Identification of cis/trans isomers of menaquinone-7 in food as exemplified by dietary supplements. Food Chem, 2018. 243: p. 403-409.*

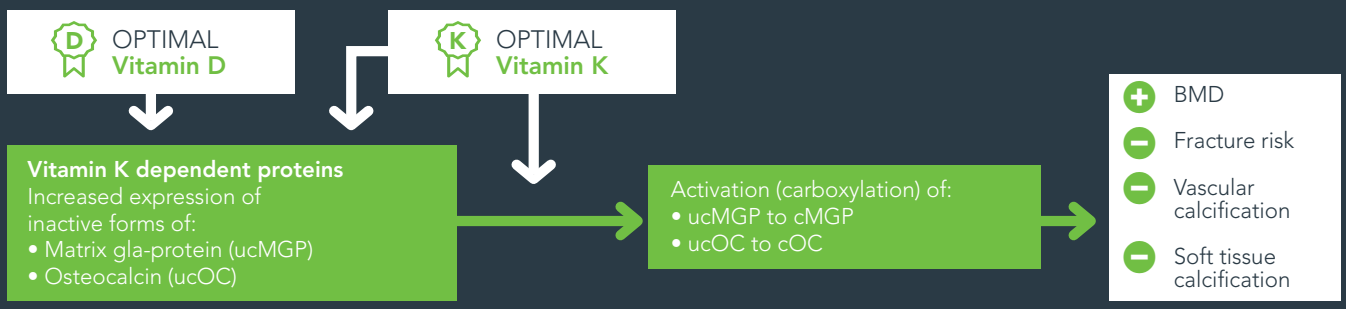
SCIENTIFIC KNOWLEDGE

FACTS

VITAMIN K2 ACTIVATES OSTEOCALCIN AND MATRIX GLA PROTEIN (MGP) WHICH TRANSFERS CALCIUM INTO BONES AND DIRECTS FREE CALCIUM AWAY FROM THE ARTERIES TO MAINTAIN HEALTHY CIRCULATION.

- K2 alongside vitamin D3 **improves vertebral bone mass** *(1, 2)*
- K2 MK-7 **improves bone microarchitecture** *(3)*
- An important population-based study *(4)* demonstrated high dietary consumption of K2 was associated with a **50% reduction in arterial calcification and cardiovascular death** and a 25% reduction in all-cause mortality
- Another population-based study found a **9% reduced risk** for coronary heart disease **for each additional 10 µg vitamin K2 consumed** *(5)*

VITAMIN K2 FOR A COMPLETE SOLUTION



van Ballegooijen et al., Int J Endocrinol 2017; 7454376

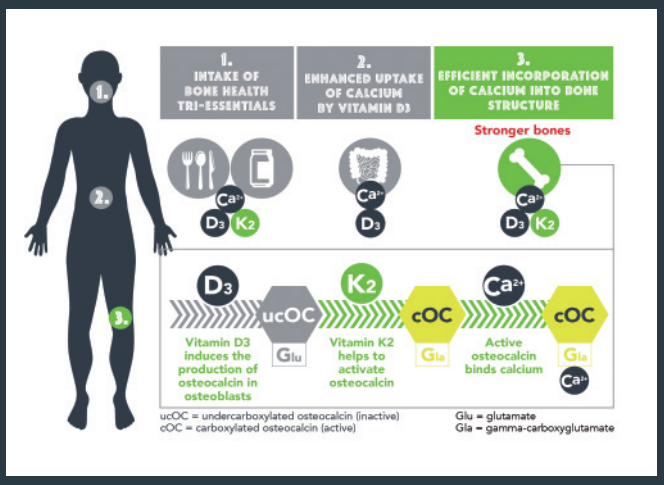
REFERENCES:
1. *Ushiroyama, T., Ikeda, A., & Ueki, M. (2002). Effect of continuous combined therapy with vitamin K2 and vitamin D3 on bone mineral density and coagulofibrinolysis function in postmenopausal women. Maturitas, 41(3), 211-221.*
2. *Iwamoto, J., Takeda, T., & Ichimura, S. (2000). Effect of combined administration of vitamin D3 and vitamin K2 on bone mineral density of the lumbar spine in postmenopausal women with osteoporosis. Journal of orthopaedic science, 5(6), 546-551.*
3. *Rønn, S. H., Harsløf, T., Pedersen, S. B., & Langdahl, B. L. (2016). Vitamin K2 (menaquinone-7) prevents age-related deterioration of trabecular bone microarchitecture at the tibia in postmenopausal women. Eur J Endocrinol, 175(6), 541-549.*
4. *Geleijnse, J. M., et al., "Dietary Intake of Menaquinone is Associated with a Reduced Risk of Coronary Heart Disease: The Rotterdam Study," J. Nutr. 134, 3100–3105 (2004).*
5. *Gast, G. C., et al., "A High Menaquinone Intake Reduces the Incidence of Coronary Heart Disease," Nutr. Metab. Cardiovasc. Dis. 19, 504–510 (2009).*

CALCIUM SUPPLEMENTATION ALONE IS NOT OPTIMAL FOR HEALTH, and must be combined with vitamins D3 and K2 to maintain bone health without putting heart health at risk.

Together with vitamin D3, K2VITAL® helps make calcium consumption safer and more effective for both bone and cardiovascular health.

VITAMIN K2 ACTIVATES OSTEOCALCIN

THE ROLE OF VITAMIN K2 IN BONE HEALTH

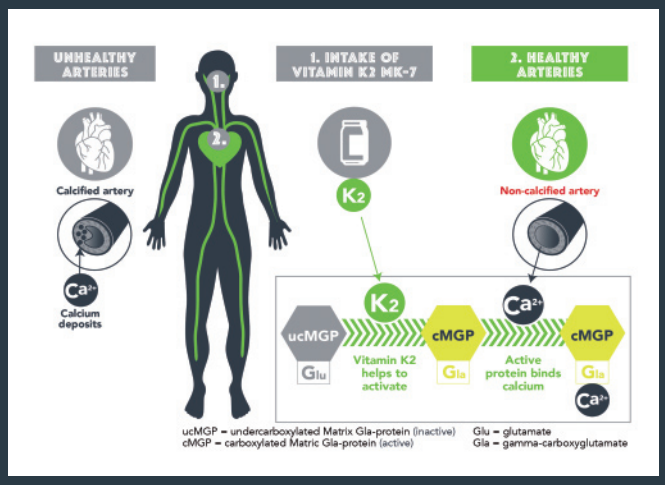


D3 + K2 AND OSTEOCALCIN

Osteocalcin is a protein present in bones secreted by osteoblasts - the so-called "bone-building cells". Osteocalcin levels have widely been accepted as a useful biomarker for the bone formation process. Higher serum osteocalcin levels are correlated to increases in bone mineral density. Only the carboxylated form of osteocalcin (activated) can bind calcium, and this carboxylation is vitamin K dependent.

VITAMIN K2 ACTIVATES MATRIX GLA PROTEIN (MGP)

THE ROLE OF VITAMIN K2 IN HEART HEALTH



D3 + K2 AND MGP

Matrix Gla protein (MGP) is another vitamin K-dependent protein. MGP production is D3-mediated. Like osteocalcin, MGP has a high affinity for calcium and can bind it via its Gla domains. MGP is predominantly found in soft tissue. It was scientifically proven that MGP inhibits vascular mineralization.

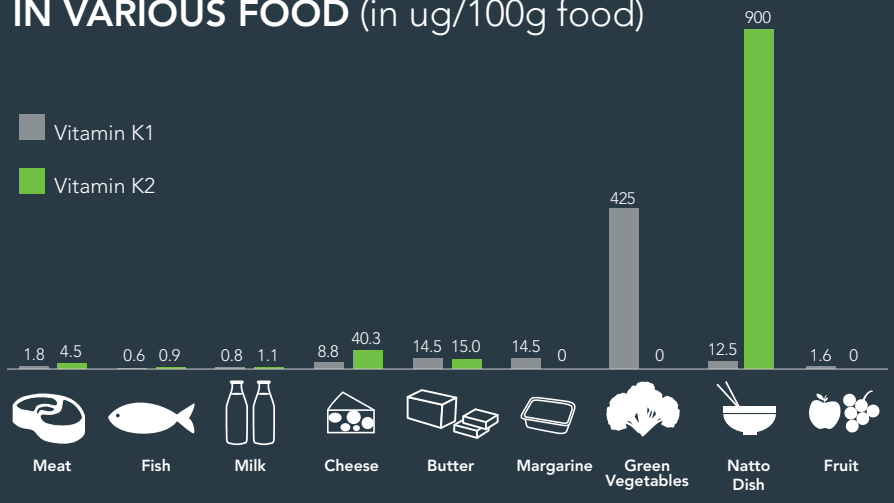
GOT ENOUGH VITAMIN K2?

DIET DEFICIENCY
Our diets are low in vitamin K2 – putting us at risk of vitamin K2 deficiency

DAILY INTAKE
The daily intake of vitamin K2 via food has decreased over the past hundred years.

MORE VITAMIN K2
For healthy bones and heart, we need more vitamin K2 as we age.

AMOUNT OF VITAMIN K1 AND K2 IN VARIOUS FOOD (in ug/100g food)



FOR OPTIMAL BONE AND HEART HEALTH K2 MUST BE SUPPLEMENTED

Research indicates that 75-120 µg of vitamin K2 as a daily dose is sufficient for good bone health. Populations that reach the recommended daily dose, such as Japanese people consuming natto (a dish high in K2 MK-7), were shown to have lower rates of bone and heart disease.

HEART

- A lack of vitamin K2 leads to calcium being deposited into the vessels.
- Vitamin K2 MK-7 has demonstrated in clinical studies to reduce arterial stiffness significantly and to slow the progression of calcification.

BONES

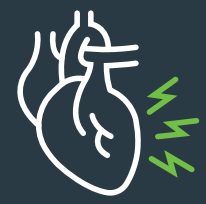
- MK-7 has shown to preserve bone structure
- In pregnant women, K2 supplementation can improve bone health of both mother and baby
- K2 balances calcium in the body, making it both safe and effective.

OFFICIAL RECOMMENDED INTAKES FOR VITAMIN K BASED ON LIFE STAGE AND GENDER

Life stage and Gender	1. EU (AI)*	2. US (AI)*	3. AUS / NZ (AI)*
Infants			
0-6 months	★	2.0 µg/day**	2.0 µg/day
7-11 months	10 µg/day**	2.5 µg/day**	2.5 µg/day
Children and Adolescent			
1-3 yrs	12 µg/day	30 µg/day	25 µg/day
4-6 yrs	20 µg/day	55 µg/day	35 µg/day
7-10 yrs	30 µg/day	60 µg/day	45 µg/day
11-14 yrs	45 µg/day	75 µg/day	55 µg/day
15-17 yrs	65 µg/day		
Adults			
Men 19+ yrs	75 µg/day	120 µg/day	75 µg/day
Women 19+ yrs	75 µg/day	90 µg/day	60 µg/day
Pregnancy and Lactation			
14-18 yrs	75 µg/day	75 µg/day	60 µg/day
19-50 yrs	75 µg/day	90 µg/day	60 µg/day

Note
The official recommended doses are based on coagulation of blood and vitamin K1 (Phylloquinone).
* **AI:** Adequate Intake.
★ No specific recommendation has been made in Annex XIII of EU Regulation 1169/2011 regarding the recommended doses of vitamin K in infants, children, pregnant women or lactating women
** For vitamin K1 phylloquinone

References
1 Annex XIII of Regulation (EU) 1169/2011. 2. https://www.nrv.gov.au/nutrients/vitamin-k 3. https://ods.od.nih.gov/factsheets/VitaminK-HealthProfessional/



CALCIFICATION OF THE ARTERIES IS CLOSELY LINKED TO INCREASED RISK OF CARDIOVASCULAR DISEASE

MK-7 SUPPLEMENTATION HELPS POSTMENOPAUSAL WOMEN AGAINST BONE LOSS

THERE IS A POSITIVE RELATIONSHIP BETWEEN VITAMIN K STATUS AND BONE MINERAL DENSITY IN CHILDREN

INFANTS ARE OFTEN DEFICIENT IN VITAMIN K

EYE

Vitamin K supplementation promotes retinal health and support better eyesight.

SPORT

K2 helps trained athletes to increase maximal cardiac output during aerobic exercise

D3 & K2
THE PERFECT PAIR

CALCIUM IS THE MOST ABUNDANT MINERAL IN THE HUMAN BODY

OVER **99%**

in bones and teeth and 1% in blood and soft tissues. Sufficient dietary calcium is essential for bone health.

VITAMIN D3 INCREASES CALCIUM ABSORPTION IN THE INTESTINES

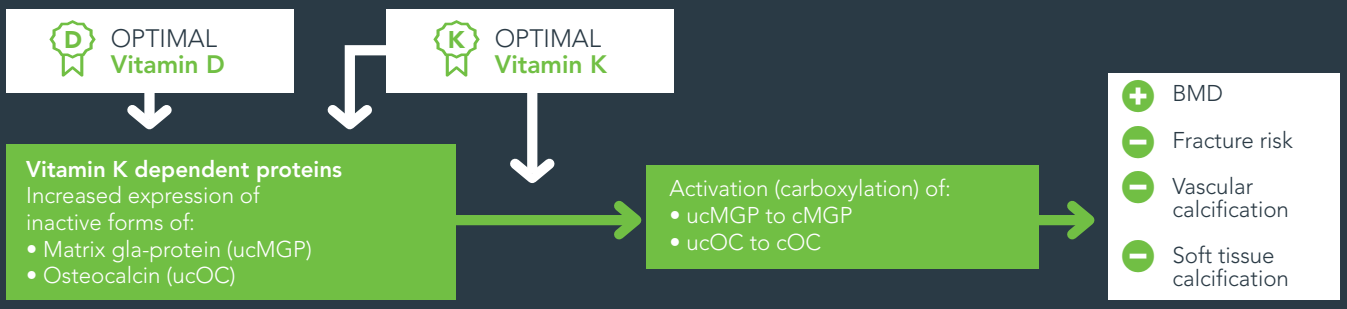
Vitamin D3 activates the expression of the calcium-binding proteins osteocalcin and matrix Gla protein (MGP). These proteins are, however, synthesized in an inactive form.

VITAMIN K2 ACTIVATES OSTEOCALCIN AND MGP THROUGH CARBOXYLATION

If intakes of vitamin K2 are inadequate, osteocalcin and MGP will remain inactive. This affects both calcium integration to build bones, and its deposition into the vascular system, which can have harmful effects.

K2VITAL®
Puts Calcium in Balance

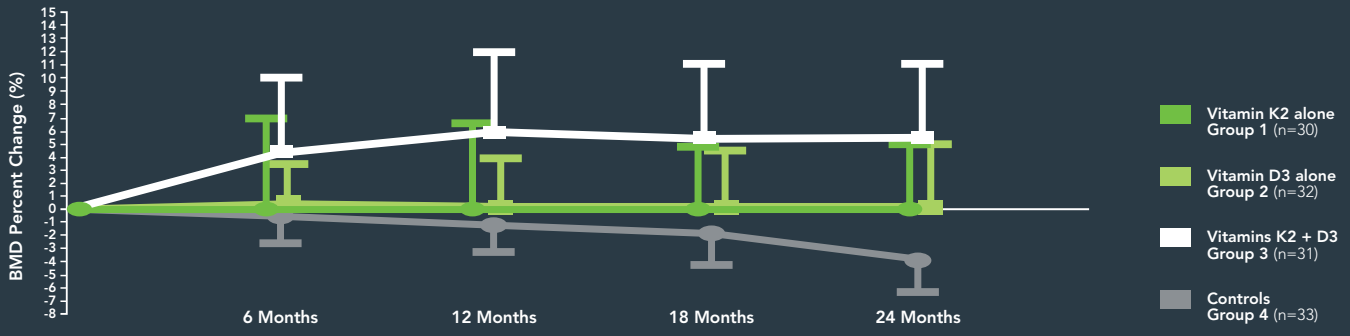
VITAMIN K2 FOR A COMPLETE SOLUTION



van Ballegooijen et al., Int J Endocrinol 2017; 7454376

D3 + K2 COMBINATION IMPROVES BONE HEALTH

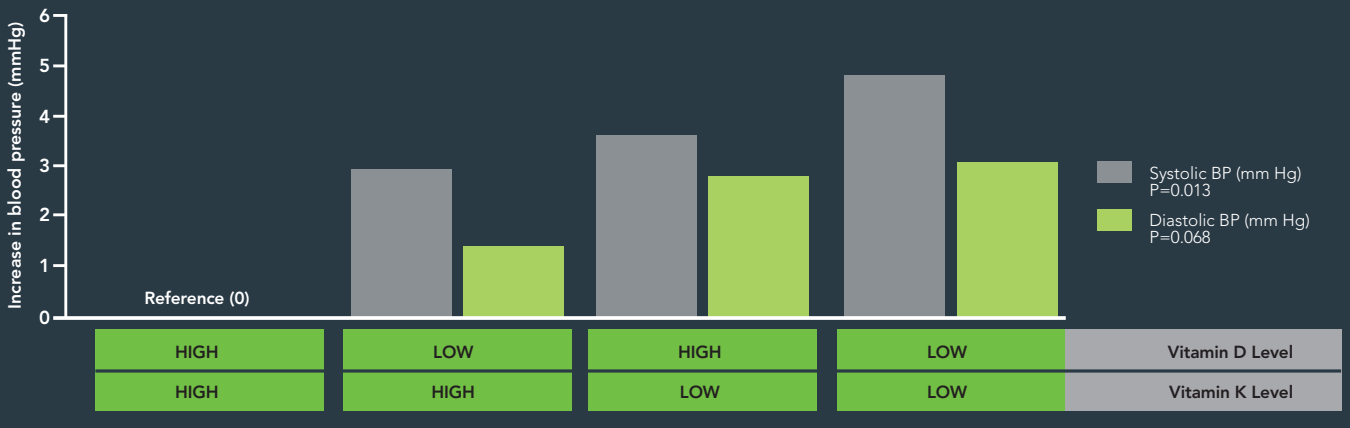
BMD EVOLUTION OVER TIME



Ushiroyama, T., Ikeda, A., & Ueki, M. (2002). Effect of continuous combined therapy with vitamin K2 and vitamin D3 on bone mineral density and coagulofibrinolysis function in postmenopausal women. Maturitas, 41(3), 211-221.

D3 + K2 COMBINATION IMPROVES HEART HEALTH

VITAMINS D AND K STATUS WITH BLOOD PRESSURE



The combination of low **vitamins D and K status was associated with increased blood pressure** and a trend for greater hypertension risk

van Ballegooijen et al., Hypertension 2017; 69(6):1165-1172

BONE HEALTH

BONES UNDERGO A NATURAL CYCLE OF DISASSEMBLY AND REGENERATION

EVERY **7 YEARS**

BONE REMODELING LEADS TO A COMPLETE REPLACEMENT OF THE SKELETON.

- **Vitamin K2 activates osteocalcin, which incorporates calcium into the bone matrix.**
- **K2 balances calcium in the body, making it both safe and effective.**

BONE METABOLISM

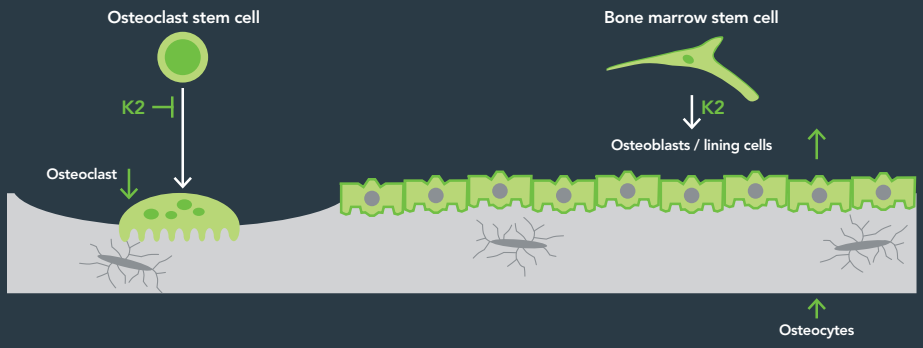
- The bone matrix contains cells that both build-up and remove old and damaged bone tissue.
- Maintenance of the proper balance between these two functions is vital for good health and must be managed throughout life.

BONE MECHANICS

Osteoblasts and osteoclasts are the two types of bone cells that breakdown and build-up bone in the bone remodeling process.

- **Osteoclasts – bone-disassembly**
- **Osteoblasts – bone-building**

REGULATION OF BONE REMODELING BY VITAMIN K2



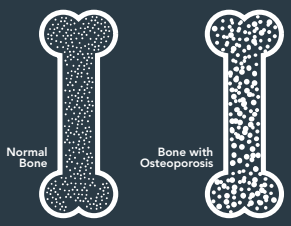
Osteoblasts secrete osteocalcin into the blood. When osteocalcin is in an activated state (carboxylated by K2), osteocalcin binds to calcium and transports it from the blood and into the bones.

Osteoblasts then integrate this calcium into the bone matrix, increasing the bone's mineral density and strength. As part of the remodeling cycle, osteoclasts remove old or damaged bone, so that it can be replaced with new bone.

HIGHER RISK OF FRAGILE BONES

The natural and expected age-related loss of bone mineral density over time increases the **risk for fragile bones that can lead to fractures.**
When we are younger, new bone is created faster than old bone is broken down.

BONE DENSITY



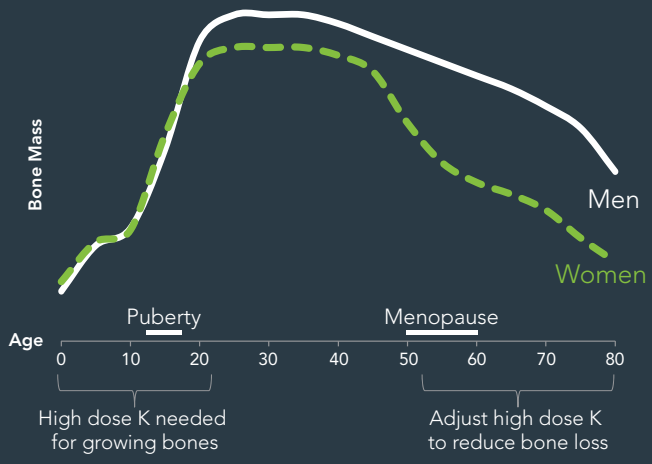
Weak bones show a loss of calcium

BONE MASS THE AGE FACTOR

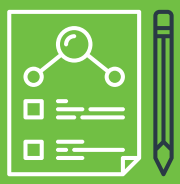
Peak bone mass is reached some time after the age of 20, where it levels off until it begins a natural decline.

With age, bones become more porous, and therefore lighter and less dense

VITAMIN K2 MK-7 FOR ALL CONSUMER SEGMENTS



The bone health benefits of K2VITAL® K2 MK-7 apply to virtually every consumer type and many top-selling market categories. Mothers and infants, children and teens, and men and women from their 20's to their 90's all require K2 for different reasons at various stages of life.



CLINICAL STUDIES DEMONSTRATE THAT VITAMIN K2:

- Supports bone growth *(1)*
- Reduces bone fracture risk *(2,3)*
- Improves bone mineral density in healthy postmenopausal women *(4)*
- Protects postmenopausal women against bone loss *(5)*

HIGH LEVELS OF UNCARBOXYLATED OSTEOCALCIN ARE LINKED TO:

- Lower bone mineral density *(6-8)*
- An increased risk of hip fractures *(6-8)*

REFERENCES:
1. *Huang, Z.B., et al., Does vitamin K2 play a role in the prevention and treatment of osteoporosis for postmenopausal women: a meta-analysis of randomized controlled trials. Osteoporos Int, 2015. 26(3): p. 1175-86.*
2. *Kaneki, M., et al., Japanese fermented soybean food as the major determinant of the large geographic difference in circulating levels of vitamin K2: possible implications for hip-fracture risk. Nutrition, 2001. 17(4): p. 315-21.*
3. *Yaegashi, Y., et al., Association of hip fracture incidence and intake of calcium, magnesium, vitamin D, and vitamin K. Eur J Epidemiol, 2008. 23(3): p. 219-25.*
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5. *Vermeer, C., Vitamin K: the effect on health beyond coagulation - an overview. Food Nutr Res, 2012. 56.*
6. *Szulc, P., et al., Serum undercarboxylated osteocalcin is a marker of the risk of hip fracture in elderly women. J Clin Invest, 1993. 91(4): p. 1769-74.*
7. *Szulc, P., et al., Serum undercarboxylated osteocalcin correlates with hip bone mineral density in elderly women. J Bone Miner Res, 1994. 9(10): p. 1591-5.*
8. *Shearer, M.J., The roles of vitamins D and K in bone health and osteoporosis prevention. Proc Nutr Soc, 1997. 56(3): p. 915-37.*

PREGNANCY & LACTATION

FACTS

Research indicates that during pregnancy, K2 is particularly important for both mother and child.

High calcium demand
During pregnancy, women can suffer from calcium deficiency due to their unborn child's high demand for calcium.

K2 deficiency
K2 deficiency during gestation can be detrimental to the unborn child as skeletal development before birth can influence proper bone formation, setting the tone for future bone health.

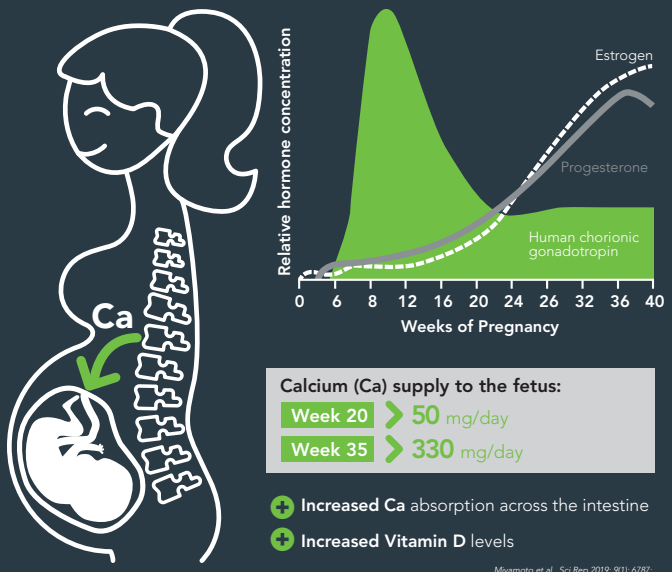
K2 in breast milk
After birth, infants might suffer from vitamin K deficiency, as the levels of vitamin K in breast milk are typically low.

K2 SUPPLEMENTATION CAN IMPROVE BONE HEALTH FOR EXPECTING MOTHERS AND REDUCE THE RISK OF BONE-RELATED PAIN.

Maintaining an adequate vitamin K2 supply during pregnancy is essential to ensure the expectant mother makes the best use of the calcium available to her and to give her child's bones the best possible start.

LACTATING WOMEN
- Research showed increased levels of vitamin K in the breast milk of new mothers who took 5 mg/day of vitamin K1.
- Vitamin K levels were elevated in the blood of their breastfed children.

BEFORE & AFTER BIRTH
- The increased need for calcium supply from mother to infant, both before and after birth, may negatively impact the mother's skeletal system without sufficient amounts of dietary calcium, vitamins D and K.



Calcium (Ca) supply to the fetus:
Week 20 > 50 mg/day
Week 35 > 330 mg/day

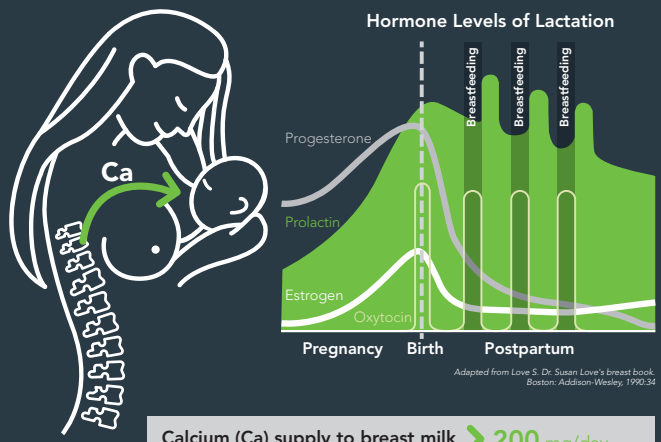
- **Increased Ca** absorption across the intestine
- **Increased Vitamin D** levels

Miyamoto et al., Sci Rep 2019; 9(1): 6787; Karlsson et al., Acta Orthop 2005; 76(1): 2-13

VITAMIN K2 IS POORLY TRANSPORTED FROM MOTHER TO UNBORN CHILD

In a controlled Japanese study, women given a high dose of vitamin K2 about a week before they gave birth had more K2 in their blood compared to women who were not given K2. Crucially, K2 levels were also elevated in umbilical cord blood, indicating increased transfer of K2 to the child. As a result, **none of the children born to K2-treated mothers showed signs of vitamin K deficiency at birth,** compared to 90% of the children whose mothers were not given vitamin K.
Interestingly, levels of vitamin K2 in breast milk on the fifth day after birth were significantly higher in women who were given K2 before they gave birth. So, the direct **benefits of K2 supplementation during pregnancy may extend to early infancy through breast milk.**

Motohara et al., J Pediatr Gastroenterol Nutr 1990; 11(1): 32-6



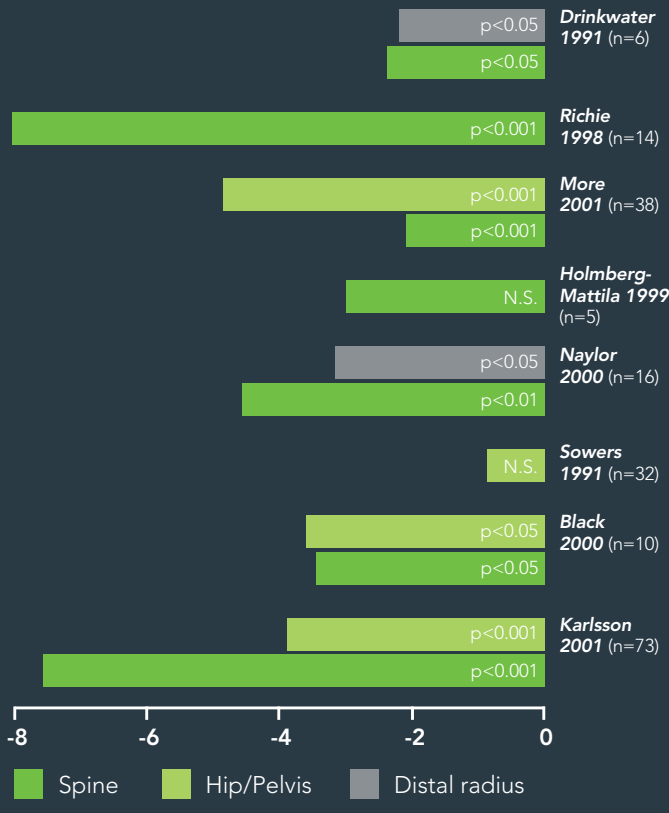
Adapted from Love S. Dr. Susan Love's breast book. Boston: Addison-Wesley, 1990:34

Calcium (Ca) supply to breast milk > 200 mg/day

- **Total calcium transfer to breast milk** is greater than what crosses the placenta (3-6 month period)

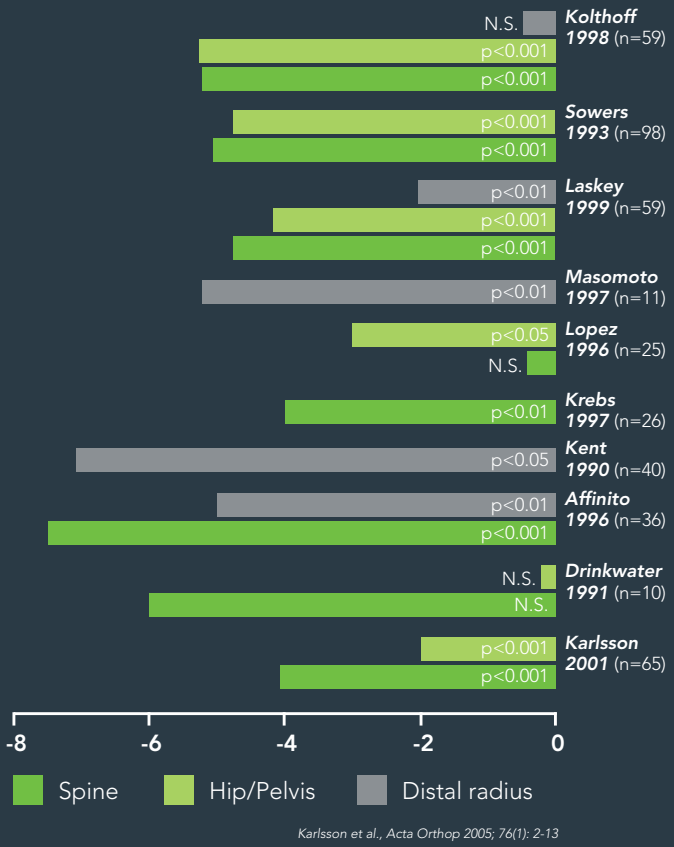
Miyamoto et al., Sci Rep 2019; 9(1): 6787; Karlsson et al., Acta Orthop 2005; 76(1): 2-13

BONE MASS CHANGES DURING PREGNANCY (%)



Karlsson et al., Acta Orthop 2005; 76(1): 2-13

BONE MASS CHANGES DURING SIX MONTHS LACTATION (%)



Karlsson et al., Acta Orthop 2005; 76(1): 2-13

INFANTS TO ADOLESCENTS

CHILDHOOD IS A PERIOD OF INTENSE SKELETAL BONE GROWTH

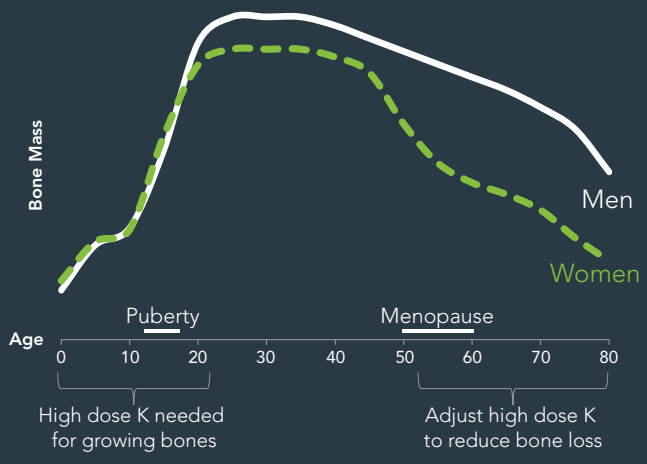
The need for vitamin K2 remains high from gestation through childhood, to adulthood and on to senior years.
After birth, infants might suffer from vitamin K deficiency as the levels of vitamin K in breast milk are typically very low. Childhood and adolescence are also no exceptions to the requirements of vitamin K2. Like infants, children can also fail to get enough vitamin K, and studies indicate that this situation may only be getting worse due to changing dietary habits.

BONE HEALTH

Bone development begins as early as six weeks after conception and continues into adulthood.
Healthy children can be suffering from a vitamin K deficiency at the cost of their current and future bone health.

HUMAN GROWTH PEAKS DURING ADOLESCENCE AND COINCIDES WITH A PERIOD OF RAPID BONE DEVELOPMENT

The more bone mass a person acquires before the age of 20-25, the more likely they are to have good bone health in later life.
K2VITAL® helps build a calcium bank in the bones.



TEENS ACQUIRE APPROXIMATELY

25% BONE MASS

in about 2 years during adolescence. This peak bone mass sets the stage for bone health throughout the remainder of life. It provides the baseline from which the natural and predictable decline (ageing) in bone density will start.

LOW BONE MASS IS A RISK FACTOR FOR FRACTURES DURING CHILDHOOD

Young adolescents may be more likely to break bones than children, perhaps because they become more physically active (on skateboards and on the sports field) at a time when their calcium intake may be inadequate to support rapid, robust bone development. **Teenagers and younger children may reduce their risk of fractures by supplementing with vitamin K2**.

K2 DEFICIENCY

Considering that our diets crucially lack sources of vitamin K2, many adolescents are likely to be K2 deficient, absent supplementation.

SUPPLEMENTATION

Supplements serving taste and haptic requirements of children and adolescents are commercially available in various forms.

75 DAILY mcg

is the set adequate intake in growing adolescents

Recommended vitamin K intakes for infants and children *(in the US)*

Age	Min. daily intake (µg/day)
0-6 months*	2.0
7-12 months*	2.5
1-3 years	30
4-8 years	55
9-13 years	60
14-18 years	75

* Only K1

BEST CHOICE

Vitamin K2 MK-7 is the best choice of vitamin K as it gives the body a much more substantial vitamin K boost compared to a similar amount of K1 and targets the bone-producing proteins that integrate calcium into bones and teeth.

K2VITAL®

WOMEN'S HEALTH

FACTS

With age, bones become more porous, and therefore lighter and less dense.

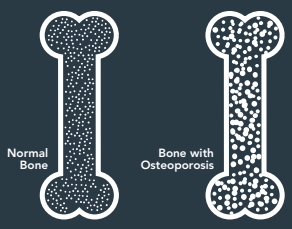
Weak bones

Weak bones show a loss of calcium in the bone mineral matrix. The highest risk for fractures comes from bone-weakening conditions such as osteopenia and osteoporosis, most commonly associated with women or certain medical conditions.

Post-menopausal years

In post-menopausal years even healthy women are at increased fracture risk compared to men.

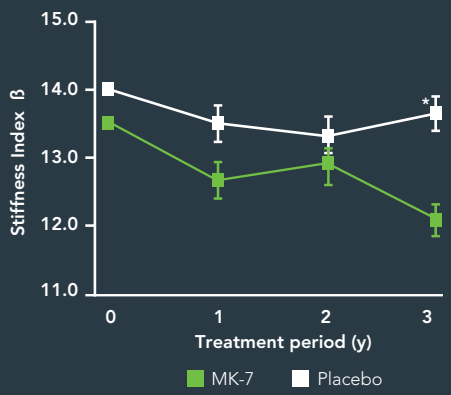
BONE DENSITY



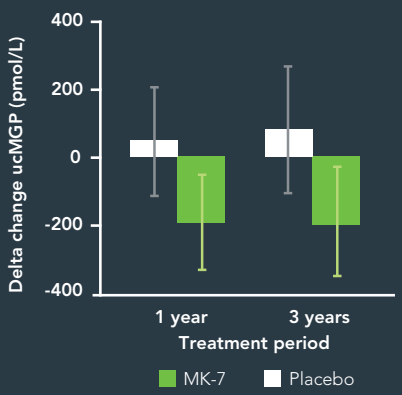
WEAK BONES SHOW A LOSS OF CALCIUM IN THE BONE MINERAL MATRIX.

LONG-TERM USE OF MK-7 SUPPLEMENTS IMPROVES ARTERIAL STIFFNESS IN HEALTHY POSTMENOPAUSAL WOMEN *(1)*

Elevated stiffness at baseline



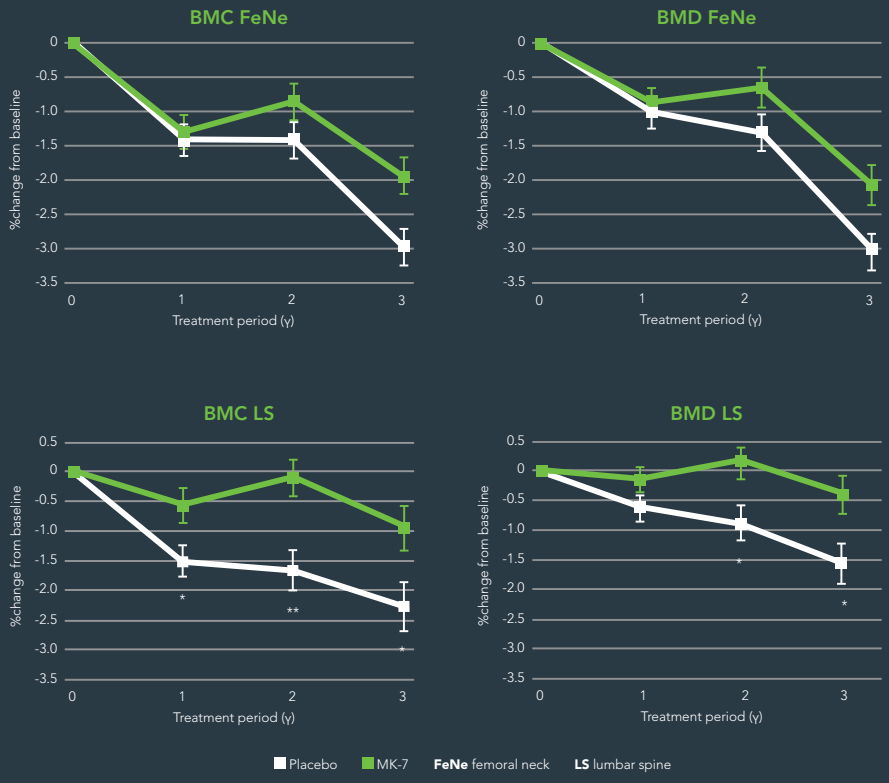
Change in serum ucMGP (mean±SD)



M.H. Knapen, et al., "Menaquinone-7 Supplementation Improves Arterial Stiffness in Healthy Postmenopausal Women: Double-Blind Randomised Clinical Trial," Thrombosis and Haemostasis 113(5), 1135–1144 (2015).

MK-7 SUPPLEMENTATION HELPS POSTMENOPAUSAL WOMEN FIGHT BONE LOSS *(2)*

Changes in bone mineral content (BMC) and bone mineral density (BMD) during the 3-year intervention



VITAMIN K2 MK-7

- **Protects postmenopausal women against bone loss** *(3)*
- Preserves bone microstructure in postmenopausal women *(4)*
- Improves arterial stiffness in healthy postmenopausal women *(2)*
- MK-7 supplementation helps protect healthy postmenopausal women against bone loss.

In a double-blind, randomized, placebo-controlled clinical trial, bone strength was investigated in 244 healthy postmenopausal women over 3 years, supplementing with either 180 µg of MK-7 or placebo *(1)*. MK-7 supplementation significantly reduced the level of inactive osteocalcin (ucOC) and increased the level of active osteocalcin The intake of MK-7 decreased the age-related decline in bone mineral content (BMC) and density (BMD) at the end of the thighbone (femoral neck) and the lower back spine (lumbar spine). Also, MK-7 significantly reduced the loss in vertebral height in the lower chest region.

REFERENCES:
1. *Knapen, M. H., et al., (2015). Menaquinone-7 supplementation improves arterial stiffness in healthy postmenopausal women. Thrombosis and haemostasis, 113(05), 1135-1144.*
2. *Knapen, M. H. J., et al., (2013). Three-year low-dose menaquinone-7 supplementation helps decrease bone loss in healthy postmenopausal women. Osteoporosis International, 24(9), 2499-2507.*
3. *Vermeer, C. V. (2012). Vitamin K: the effect on health beyond coagulation–an overview. Food & nutrition research, 56(1), 5329.*
4. *Rønn, S. H., et al., (2016). Vitamin K2 (menaquinone-7) prevents age-related deterioration of trabecular bone microarchitecture at the tibia in postmenopausal women. Eur J Endocrinol, 175(6), 541-549.*

HEART HEALTH

FACTS

Studies on the effect of vitamin K2 MK-7 on cardiovascular health demonstrate a significant reduction in arterial stiffness and slower progression of calcification.

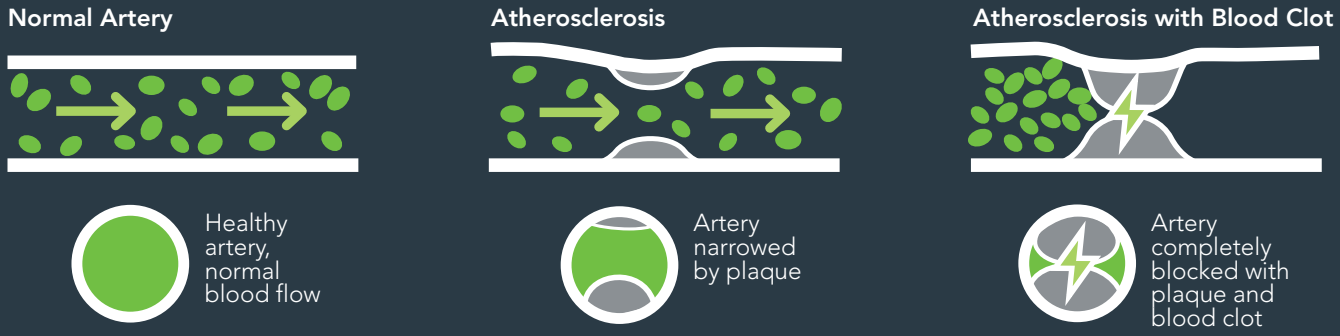
Calcification

Vascular calcification reduces arterial elasticity and results in stiffening of the vessels. An inverse correlation between calcification of vessels and survival has been observed *(1)*. One of the strongest inhibitors of vessel calcification is the vitamin K-dependent matrix Gla protein (MGP).

K2VITAL® activates MGP

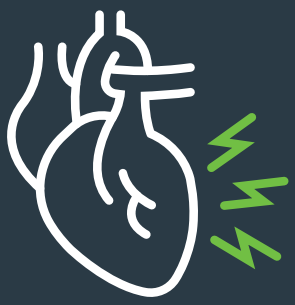
In the presence of vitamin K2, MGP is activated by carboxylation to become cMGP, which interacts with calcium in the bloodstream and regulates calcification in the vessel walls. With low levels of vitamin K2 in the blood stream, MGP is present in its inactive form, which is in a dephosphorylated and undercarboxylated state (dp-ucMGP) and will not be able to interact with calcium. This may lead to a higher calcification in the vessel wall.

PROGRESSION OF ATHEROSCLEROSIS



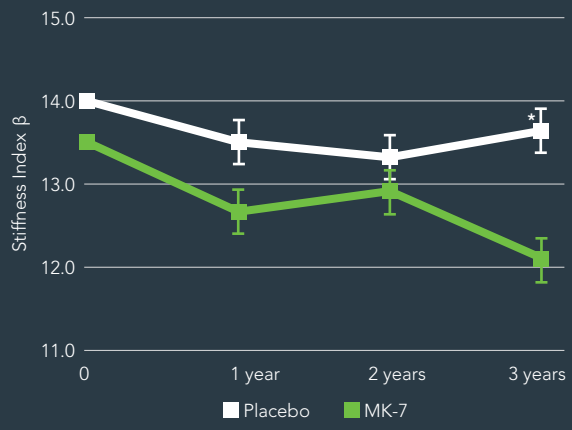
VITAMIN K2 MK-7: A CLINICALLY PROVEN HEART HEALTH INGREDIENT

HIGH MENAQUINONE INTAKES HAVE BEEN ASSOCIATED WITH A REDUCTION IN THE INCIDENCE OF HEART DISEASE *(1)*

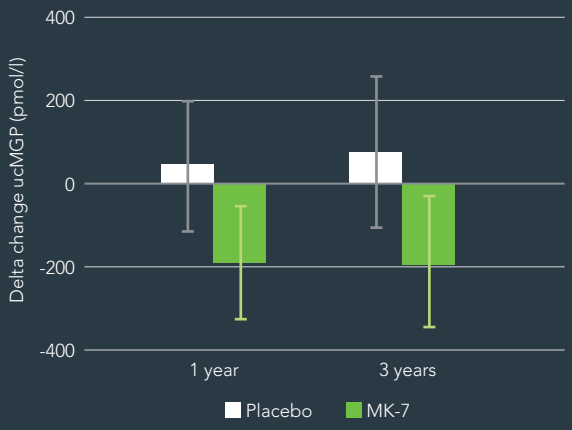


CALCIFICATION OF THE ARTERIES IS CLOSELY LINKED TO INCREASED RISK OF CARDIO-VASCULAR DISEASE.

CHANGES IN ARTERIAL STIFFNESS INDEX BY MK-7 OVER A 3-YEAR INTAKE *(2)*



MK-7 REDUCES THE LEVEL OF INACTIVE MGP (ucMGP) OVER THREE YEARS *(2)*



ARTERIAL STIFFNESS WAS REDUCED WITH A 3-YEAR MK-7 SUPPLEMENTATION

In a double-blinded, randomized, placebo-controlled clinical trial, arterial stiffness was investigated in 244 healthy postmenopausal women over a period of 3 years, supplemented with either 180 µg of MK-7 or a placebo. Among the participants with an elevated arterial stiffness at baseline, the stiffness index was significantly improved compared to the placebo group ($p<0.05$). A beneficial effect of MGP activation was also seen among the participants taking MK-7 which experienced a 50% decrease in circulating dp-ucMGP compared to the placebo group ($p<0.0001$). Several other studies have demonstrated heart health benefits of vitamin K2 MK-7. *(1)*

REFERENCES:
1. *Gast GC, de Roos NM, Sluijs I, Bots ML, Beulens JW, Geleijnse JM, Witteman JC, Grobbee DE, Peeters PH, van der Schouw YT. A high menaquinone intake reduces the incidence of coronary heart disease. Nutr Metab Cardiovasc Dis. 2009;19:504–510. doi: 10.1016/j. numecd.2008.10.004.*
2. *Knapen M.H., et al., Menaquinone-7 supplementation improves arterial stiffness in healthy postmenopausal women. Thrombosis and haemostasis, 2015.113(05):1135-44.*

ATHLETES & SPORTS NUTRITION

STRONG BONES
Calcium is needed by athletes for skeleton building, muscle contraction, nerve signalling and other metabolic processes.

VESSEL FLEXIBILITY
Vitamin K2 prevents calcium deposit in arteries and vessels, helping them remain soft and flexible. *(1, 2)*

VITAMIN K2 MK-7
Calcium is required for proper muscle contraction and K2 regulates calcium distribution in the body.

RESISTANCE TRAINING CAN LEAD TO MUSCLE DAMAGE AND SORENESS THAT LIMITS PERFORMANCE IN THE FOLLOWING 1-2 DAYS.

This muscle damage is accompanied by a local inflammatory response. Vitamin K2 has been shown to have anti-inflammatory activity that could be beneficial for muscle recovery.

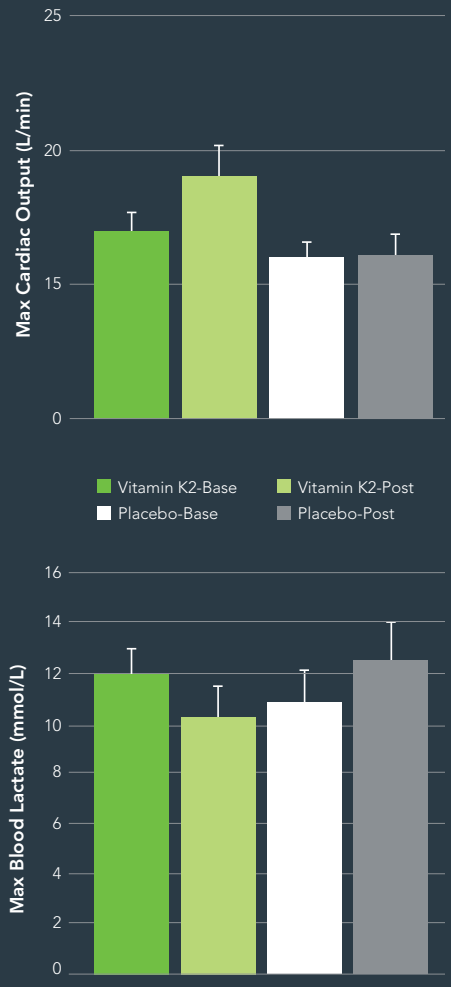
THE DAILY INTAKE OF 180 µg MK-7 can reduce arterial stiffness *(1)*. Vitamin K2 may also help clear existing calcium blockage in arteries and return vessel flexibility – aiding athletic performance by increasing the body's ability to do work.

REDUCED RISK FOR BONE FRACTURES AND BREAKS

K2 studies demonstrate reduced risk for significant bone fractures and breaks *(3, 4)*, preservation of bone microstructure *(5)*, and improved BMD *(6)*. Higher BMD in younger athletes provides protection for contact sports. Older athletes may be able to pursue sports they love with the aggressiveness they remember for a little longer. K2 demonstrates a body of clinical science that shows risk reduction of bone fracture.

VITAMIN K2 HAS BEEN SHOWN TO HAVE ANTI-INFLAMMATORY ACTIVITY THAT COULD BE BENEFICIAL FOR MUSCLE RECOVERY.

STUDY ON TRAINED ATHLETES DEMONSTRATED THAT K2 MK-7 SUPPLEMENTATION INCREASED MAXIMAL CARDIAC OUTPUT BY 12% *(7)*



McFarlin et al. estimate that K2 supplementation provided results equivalent to 6 to 9 months of continuous training. The authors speculate that K2 supplementation during exercise may reduce the required training time by 60% to achieve comparable increases in maximal cardiac output. K2 supplementation was also observed in parallel with lower maximal blood lactate, implying an effect on the ability of the muscle to maintain a high level of activity.

Trained athletes were supplemented with K2 MK-7 or a placebo for 8 weeks. The MK-7 group was dosed in a four-week loading phase at 320 mcg per day, followed by a maintenance phase at 160 mcg for the remaining period. Cardiovascular performance was measured by an exercise test on a cycle ergometer and compared to baseline results for heart rate, stroke volume, cardiac output, oxygen consumption and blood lactate.

In addition to a significant 12% increased maximal cardiac output, the study reported increased heart rate and decreased blood lactate measures, but not with statistical significance. The authors speculate that a low sample size may have contributed to this lack of significance, and with additional participants findings may translate to greater effect.

K2 DEFICIENCY

Studies suggest that K2 may help avoid lesser fractures, the type associated with the stresses of repetitive motion/impact sports like running.

INCREASED POWER

By preventing calcium-induced stiffening of vessels and arteries, and reversing existing calcification, vitamin K2 increases the body's ability to do work.

CRAMP REDUCTION

Studies demonstrate that vitamin K2 can reduce or prevent the improper contraction of muscle, commonly known as muscle cramp *(8)*.

REFERENCES:
1. *Knapen, M.H., et al., Menaquinone-7 supplementation improves arterial stiffness in healthy postmenopausal women. A double-blind randomised clinical trial. Thromb Haemost, 2015. 113(5): p. 1135-44.*
2. *Kurnatowska, I., et al., Effect of vitamin K2 on progression of atherosclerosis and vascular calcification in nondialyzed patients with chronic kidney disease stages 3-5. Pol Arch Med Wewn, 2015. 125(9): p. 631-40.*
3. *Kaneki, M., et al., Japanese fermented soybean food as the major determinant of the large geographic difference in circulating levels of vitamin K2: possible implications for hip-fracture risk. Nutrition, 2001. 17(4): p. 315-21.*
4. *Yaegashi, Y., et al., Association of hip fracture incidence and intake of calcium, magnesium, vitamin D, and vitamin K. Eur J Epidemiol, 2008. 23(3): p. 219-25.*
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6. *Knapen, M.H., et al., Three-year low-dose menaquinone-7 supplementation helps decrease bone loss in healthy postmenopausal women. Osteoporos Int, 2013. 24(9): p. 2499-507.*
7. *McFarlin, B.K., A.L. Henning, and A.S. Venable, Oral Consumption of Vitamin K2 for 8 Weeks Associated With Increased Maximal Cardiac Output During Exercise. Altern Ther Health Med, 2017. 23(4): p. 26-32.*
8. *Mehta, D.S., et al., Therapeutic activity and safety of vitamin K 2-7 in muscle cramps: an interventional case-series. The Indian Practitioner, 2010. 63(5): p. 287-291.*

CLAIMS

VITAMIN K2 MK-7 HEALTH & STRUCTURE FUNCTION CLAIMS

US FDA-GUIDELINE STRUCTURE FUNCTION CLAIMS:

BONE AND HEART HEALTH

- **Vitamin K2 (MK-7)** helps bind/transfer/deposit calcium into bones for strong bone development and directs free calcium away from the arteries to maintain healthy circulation.
- **Vitamin K2 (MK-7)** plays an important role in bone and heart health by activating key proteins that help transfer/bind/deposit calcium into bone and direct free calcium away from the arteries. These processes help promote strong bone development and the maintenance of a healthy circulation.

FDA-GUIDELINE STRUCTURE FUNCTION CLAIMS

FDA-guideline Structure Function Claims were developed for dietary supplements to describe scientifically-proven benefits of a supplement for body structure or function. Claims are constructed based upon the most valid and reliable studies and may not suggest that a supplement has drug-like benefits.

VITAMIN K2 (MK-7)
HAS AN IMPORTANT FUNCTION FOR BONE DEVELOPMENT IN CHILDREN

VITAMIN K2 (MK-7)
IS NECESSARY TO ACTIVATE A PROTEIN THAT DEPOSITS CALCIUM INTO THE BONE.

VITAMIN K2 (MK-7)
ACTIVATES A PROTEIN THAT DIRECTS CALCIUM AWAY FROM THE ARTERIES

VITAMIN K2 (MK-7)
HELPS MAINTAIN A HEALTHY CIRCULATORY SYSTEM

US FDA-GUIDELINE
STRUCTURE FUNCTION CLAIMS:
BONE HEALTH

- **Vitamin K2 (MK-7)** is necessary to activate a protein that deposits calcium into the bone.
- **Vitamin K2 (MK-7)** has an important function in bone development.
- **Vitamin K2 (MK-7)**, along with calcium and vitamin D, has an important role in bone formation.
- **Vitamin K2 (MK-7)** helps maintain healthy bone mass in postmenopausal women.
- **Vitamin K2 (MK-7)** helps maintain healthy bone structure in postmenopausal women.
- **Vitamin K2 (MK-7)** at nutritional levels is important for maintaining healthy bone in postmenopausal women.
- Clinical studies demonstrate that vitamin K2 (MK-7) has a role in maintaining healthy bone mass and structure in postmenopausal women.
- **Vitamin K2 (MK-7)** is important for the activation of a protein that is necessary for bone development in children.
- **Vitamin K2 (MK-7)** has an important function for bone development in children.
- **Vitamin K2 (MK-7)** has an important role in bone growth in children.

US FDA-GUIDELINE
STRUCTURE FUNCTION CLAIMS:
CARDIOVASCULAR

- **Vitamin K2 (MK-7)** helps maintain flexible arteries in postmenopausal women.
- **Vitamin K2 (MK-7)** helps maintain healthy circulation in postmenopausal women.
- **Vitamin K2 (MK-7)** helps maintain a healthy circulatory system.
- **Vitamin K2 (MK-7)** helps maintain a healthy heart.
- **Vitamin K2 (MK-7)** activates a protein that directs calcium away from the arteries.
- Aerobically trained athletes experience a reduced maximal cardiac output due to extended training.
- **Vitamin K2 (MK-7)** may help trained athletes maintain maximal cardiac output during aerobic exercise.

K2VITAL®

K2 MK-7
BIOLOGICALLY SUPERIOR, EFSA APPROVED

EFSA vitamin K approval is limited to the K1 and K2 MK-7 forms, making MK-7 the default commercial standard (MK-6 may be present to a 'minor extent' as per Commission Implementing Regulation (EU) 2017/2470). While other MK forms are used for dietary supplementation or may be present in K2 products, their presence is non-EFSA approved or fundamentally an impurity.

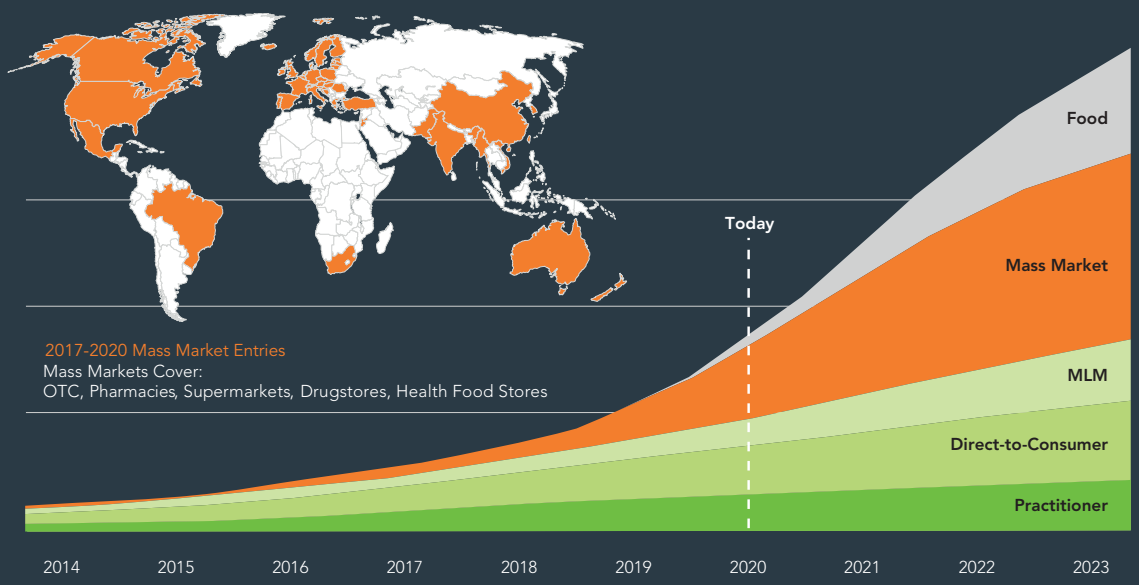
EFSA AUTHORIZED CLAIMS
FOR BONE AND CARDIOVASCULAR HEALTH

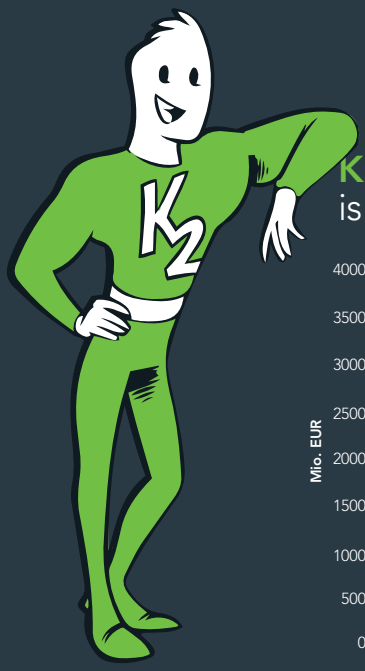
- **Vitamin K** contributes to normal blood clotting
- **Vitamin K** contributes to the maintenance of normal bones

K2 IS IN DEMAND

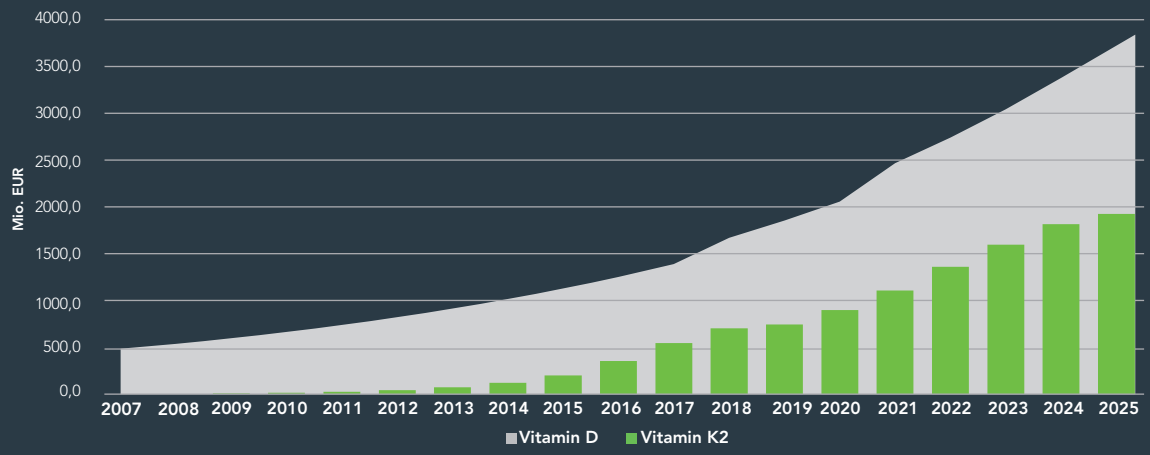
Vitamin K2 has quickly moved from the health-practitioner channel to mainstream as more and more consumers and brand owners have become aware of K2's compelling health benefits, ease of dosing and appealing cost-in-use.
In addition, K2's awareness has grown as leading bone, heart and multi-vitamin brands have adopted K2 as a key differentiator.
Kappa's K2VITAL® is now available in most pharmacies, supermarkets, specialty health stores and online.

MARKET CHANEL DEVELOPMENT

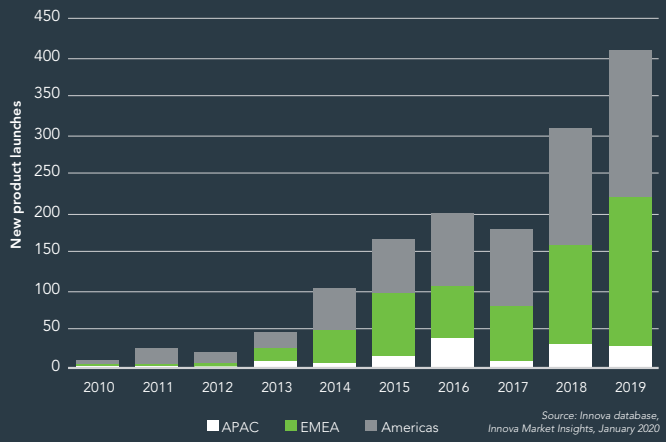




K2'S GLOBAL GROWTH RATE
is on track to replicate D3's market acceptance



K2 NEW PRODUCT LAUNCHES HAVE PROPELLED MASS MARKET ADOPTION WORLDWIDE



Source: Innova database, Innova Market Insights, January 2020

K2 + D3 MAJOR SUCCESS

	Market forecast	Intent to purchase
Vitamin K2 + D3	82	10%
Calcium *(with and without D3)*	78	12%
Vitamin D *(concept average)*	75	9%
Vitamin K1 *(concept average)*	70	8%

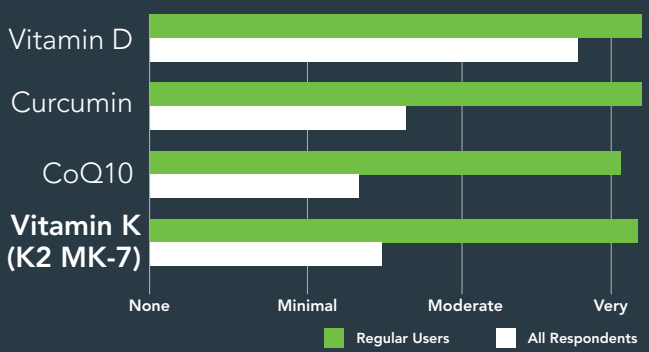
Source: Custom Concept Report prepared for Kappa Bioscience AS by New Hope Network, 2018

Research among 2000 US consumers indicates that K2 + D3 is an ideal combination for bone benefits - significantly more appealing than Calcium and/or D3 alone.

BRANDS WITH K2 MUCH MORE APPEALING

Consumer concept surveys proved that when K2 is added to leading brands such as Centrum®, Caltrate®, MegaRed®, Nature's Bounty®, and Nature Made®, these brands become more appealing and will generate incremental top-line sales.

K2 USAGE LEVELS



THE PRICE IS RIGHT

FACTS

Statistics regarding ingredient cost development from 2009-2020 show that vitamin K2 prices are cost-effective for any formulation.

Single Benefit Supplement Costs

While the cost per dose for single benefit supplements with high demand (i.e. boswellia or collagen) can be as high as 12 cents, cost per dose for multi-vitamins and most fortified food applications must be around 2 cents or lower.

Commercial Price Levels

Through continuous improvements in R&D and manufacturing, Kappa has achieved cost-per-dose levels that meet the needs of major multi-vitamin and food brands.

45%

PRICE REDUCTION

In 2017, Kappa Bioscience became market leader with a 45% price reduction.

<2,0 CENTS

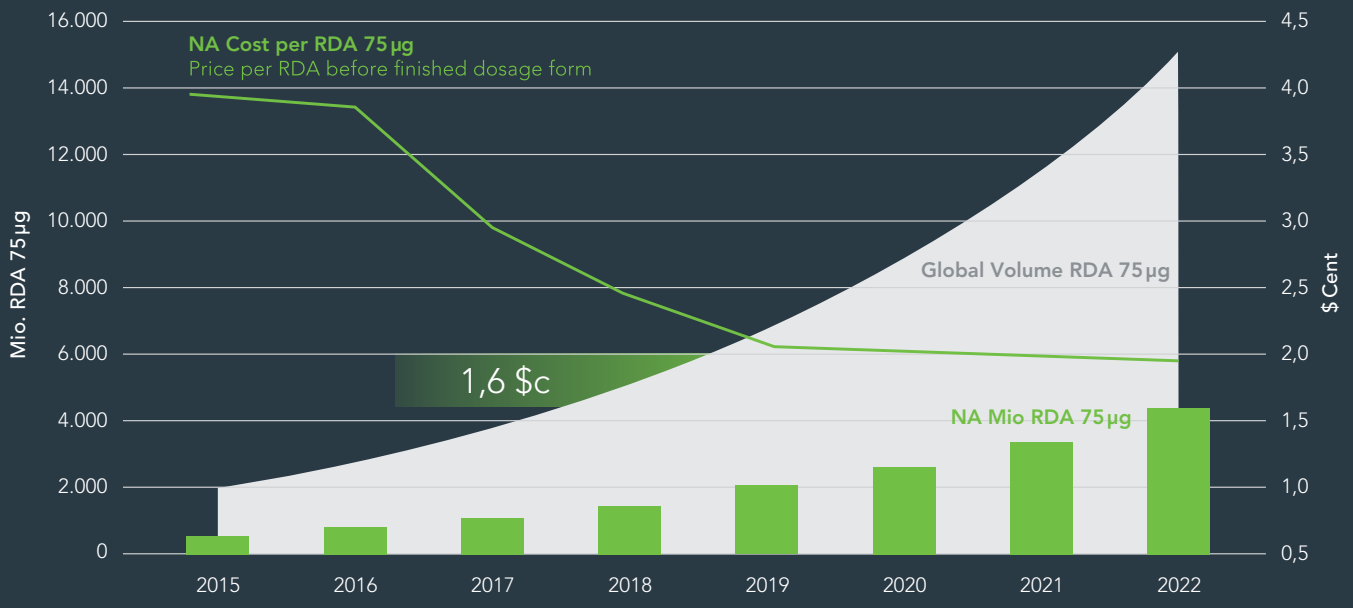
PER K2VITAL® DOSE

The cost per dose of K2VITAL® is now below 2 cents making K2 relevant for multi vitamins and fortified foods at efficacious levels.

GLOBAL MARKET

Mass market commercialization of K2 has been achieved by Kappa's reinvestment in production capabilities to meet exploding worldwide demand.

THE FOLLOWING GRAPHS EXPLAIN THE CORRELATION OF PRICE-PER-SERVING AND SCIENTIFICALLY-BACKED DAILY INTAKE RECOMMENDATIONS.

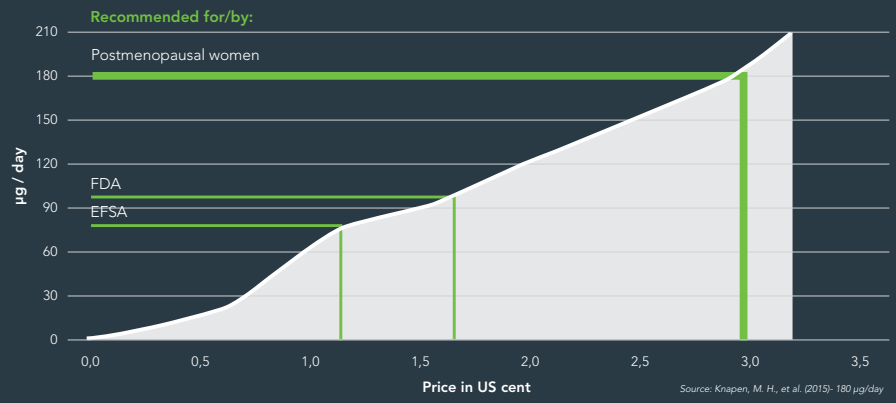


NA: North America. Mio.: million

Sources: Global Vitamin K2 Market Data Survey, MarketResearch.biz / Internal estimates based on publically available data like annual reports, industry publications as well as internall records.

BONE AND HEART HEALTH

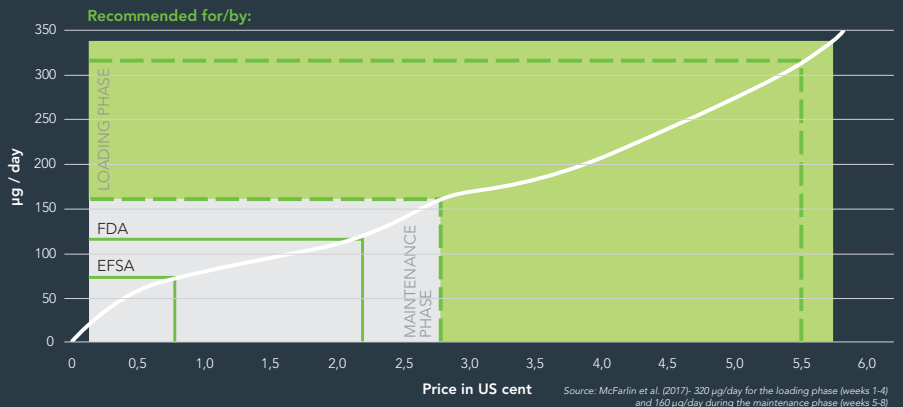
Scientifically recommended Intake levels of Vitamin K2 MK-7



Source: Knapen, M. H., et al. (2015)- 180 µg/day

SPORTS PERFORMANCE

Scientifically recommended Intake levels of Vitamin K2 MK-7



Source: McFarlin et al. (2017)- 320 µg/day for the loading phase (weeks 1-4) and 160 µg/day during the maintenance phase (weeks 5-8)

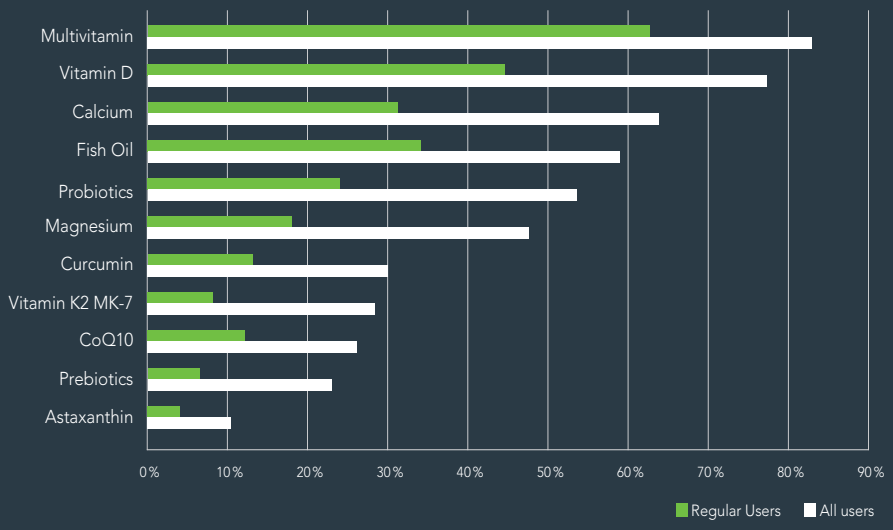
SYNERGISTIC CO-INGREDIENTS & DOSE FORMS

FACTS

Synergy
K2 complements leading dietary supplement ingredients to be the perfect partner for bone and heart health.

Unlimited Combinations
K2 in combination with omega-3, magnesium, and CoQ10 can promote improvements in arterial function. Further, K2 when paired with D3, and Calcium, delivers a triple win in bone-building benefits.

AVERAGE USAGE



K2 USAGE IS GROWING RAPIDLY AND WILL MATCH MUCH LARGER, MORE ESTABLISHED NUTRIENTS IN THE NEAR FUTURE

SCIENCE SUGGESTS OTHER BENEFIT AREAS INCLUDE JOINT AND EYE HEALTH ALONG WITH SPORTS PERFORMANCE GAINS

INGREDIENT	USAGE POPULARITY	TREND	SYNERGY WITH K2	BONES	GROWTH	JOINTS	HEART	SPORTS	VISION
Vitamin D	66.0%	→	★★★	✓	✓	✓	✓	✓	✓
Magnesium	53.5%	↗↗	★★	✓			✓	✓	
Omega-3	52.5%	↘	★★			✓	✓	✓	✓
CoQ10	45.7%	↘	★★				✓	✓	
Multivitamins	42.2%	→	★★	✓	✓	✓	✓	✓	✓
Probiotics	38.9%	↘	★	✓		✓	✓	✓	
Curcumin	34.8%	↘↘	★			✓	✓	✓	
B-complex	31.2%	↘	★★	✓	✓		✓	✓	✓
Calcium	27.0%	→	★★★	✓	✓			✓	
Vitamin K	21.8%	↗		✓	✓	✓	✓	✓	✓
Collagen	20.0%	↗↗	★			✓		✓	

Adapted from ConsumerLab.com Survey of Vitamin and Supplement Users (2020)

PURE K2 MK-7

The raw material used for manufacturing K2VITAL® is a crystalline powder, 100% pure K2 MK-7. The pure MK-7 as raw ingredient is difficult to dose in its concentrated form and is therefore diluted to produce lower concentrations.

DILUTION

Dilution can be carried out:

- In a dry form as a powder (K2VITAL® MCC)
- In a liquid form as an oil (K2VITAL® MCT)
- In its microencapsulated form – K2VITAL® DELTA as powder – is offered for liquid and dry applications in which the stability of MK-7 would be at risk

AN OVERVIEW OF COMMERCIALLY AVAILABLE K2VITAL® PRODUCTS AND THEIR INGREDIENTS

	K2VITAL® MCT		K2VITAL® MCC	K2VITAL® DELTA	
Concentration	5.00%	1.00%	1.00%	1.00%	0.20%
Form	Oil		Powder	Microencapsulated Powder	
Carrier	Medium-chain Triglyceride Oil		Microcrystalline Cellulose Medium-chain Triglyceride Oil	Sucrose Corn Starch Gum Arabicum Medium-chain Triglyceride Oil Tri-calcium phosphate	
Σ 45 µg MK-7/kg	1.111.111	222.222	222.222	222.222	44.444
Σ 75 µg MK-7/kg	666.667	133.333	133.333	133.333	26.667
Σ 90 µg MK-7/kg	555.556	111.111	111.111	111.111	22.222
Σ 180 µg MK-7/kg	277.778	55.556	55.556	55.556	11.111
Σ 380 µg MK-7/kg	131.579	26.316	26.316	26.316	5.263
Commercially available	available	available	available	available	available
Dry powder formulations	✖	✖	(✓)	✓	✓
Oil based liquid formulations	(✓)	(✓)	✖	(✓)	(✓)
Water based liquid formulations	✖	✖	✖	(✓)	(✓)
Soft capsule and pastille formulations	(✓)	(✓)	✖	✓	✓

✓ unrestricted usability (✓) partial usability ✖ inappropriate

K2VITAL® DELTA

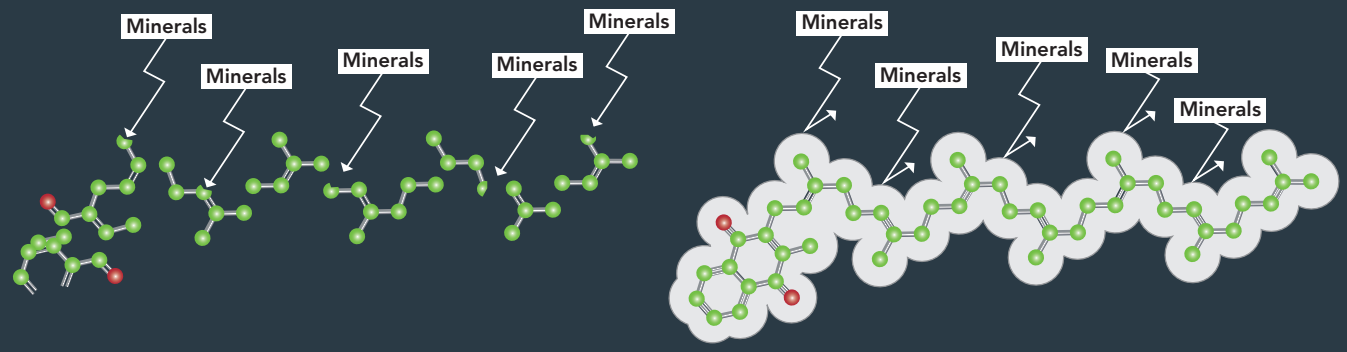
FACTS

K2VITAL® DELTA – because stability matters

Problem solved
To solve K2+minerals stability, Kappa developed protected, microencapsulated K2VITAL® DELTA.

Stability
K2VITAL® DELTA features two water-dispersible coatings that make the K2 MK-7 more resistant to harsh environments. K2VITAL® DELTA is pure, concentrated MK-7 in a spray-dried, double-coated beadlet microencapsulation. This solution creates a stable MK-7 molecule and a product with good flow and handling properties.

Less overage
K2VITAL® DELTA provides extra tolerance in manufacturing and delivers testable, provable product stability with less overage in product manufacturing.



Microencapsulated K2VITAL® DELTA is stable when combined with calcium and magnesium.

NEW RANGE
K2VITAL® DELTA launched new categories of K2 products and opened K2 to a new range of product formulations.

BONE, HEART AND MULTI
The Bone, Heart and Multivitamin categories which often use minerals were opened to vitamin K2.

HEALTHY AGEING AND SPORTS
Categories such as Healthy Ageing and Sports can now include, with the help of protected K2VITAL® DELTA, vitamin K2.

K2VITAL® DELTA REPRESENTS OVER 12% GLOBAL K2 SALES

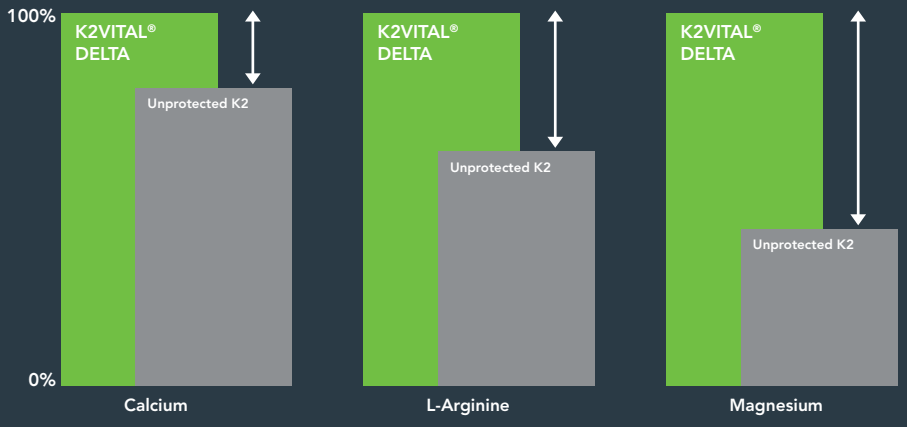
THE PROBLEM OF K2 + MINERALS INSTABILITY HAS FINALLY BEEN ACCEPTED by markets as proven by launches of other stability-enhanced MK-7 products. **While none have the commercial track-record or 3+ years stability data of DELTA,** they do validate Kappa's long-held position that in some formulations, MK-7 requires protection.

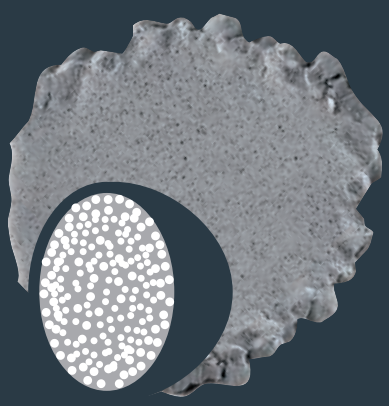
3+ YEARS STABILITY DATA

K2VITAL® DELTA

SUPERIORITY CONFIRMED IN OVER 400 TESTS

K2VITAL® DELTA SUPERIOR STABILITY
3 MONTHS RECOVERY DELTA VS UNPROTECTED/FERMENTED K2





SHELF-LIFE & STABILITY

MK-7 PURITY, STABILITY AND MICROENCAPSULATION

FACTS

In 2012, Kappa discovered that standard MK-7 is incompatible with minerals like calcium or magnesium and high-alkaline environments.

K2 is typically not shelf-stable

At a decay rate with calcium of approximately 50% in 6 months, and near 100% with magnesium, standard K2 products are typically not shelf-stable and therefore unable to deliver on MK-7 label claim/K2 health benefits.

Challenging problems

This posed a particularly challenging problem for K2 because calcium and magnesium provide similar bone and heart health benefits. Both are frequent co-ingredients in K2 formulations.

HIGHLY SENSITIVE

Vitamin K is highly sensitive to light and alkalis.

SENSITIVE

Vitamin K is sensitive to oxidising agents.

HARDLY OR NOT SENSITIVE

Vitamin K hardly sensitive to reducing agents, heat, humidity and acids.

101
TESTED PRODUCTS

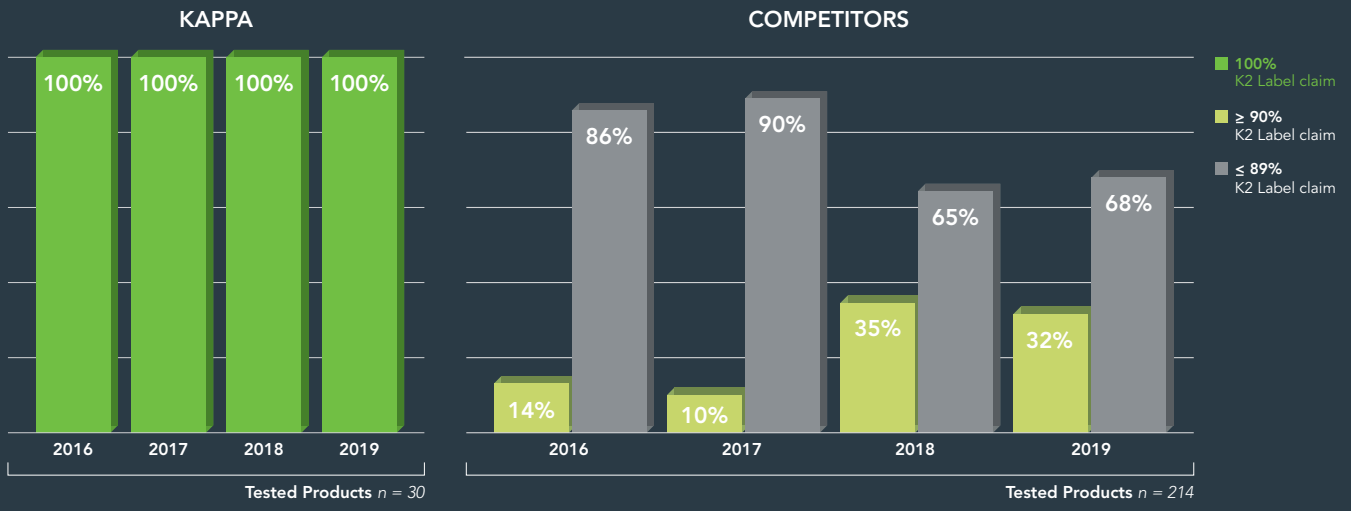
In 2013, Kappa Bioscience began an analytical program testing 101 vitamin K2 products for stability or label claim. These products were purchased from retailer shelves in a variety of formats and formulations. Consumer product testing of hundreds K2+minerals products, demonstrate that on average 90% fail.

4/10 PRODUCTS HAD NO DETECTABLE VITAMIN K2.

SPOT TESTING

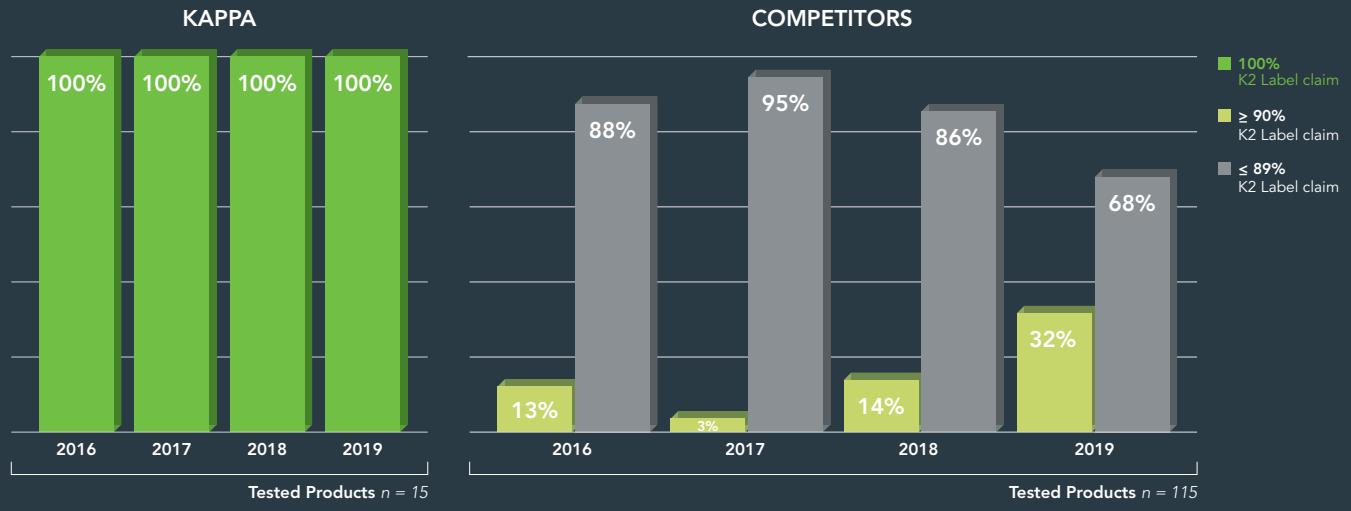
Kappa encourages brands to conduct independent, USP-method spot-testing of their products. Spot testing consumer products at least 6 months after the date of manufacture, using correct USP methods, is the most effective way to evaluate stability-related marketing claims and materials.

K2VITAL® DELTA **vs. Competitive K2 MK-7**
Average Label Claim: Mineral Formulations



Note: 2016 cutoff chosen due to inconsistent distributions in previous years.

K2VITAL® DELTA **vs. Competitive K2 MK-7**
Average Label Claim: Bone Health Products



THE K2VITAL® FORMULATION LOOKBOOK

VITAMIN K2 MK-7 CAN BE INCORPORATED INTO A VERY WIDE RANGE OF PRODUCT FORMATS – FROM CANDY TO CAPSULE, TABLET TO SYRUP.

FAST DEVELOPMENT

To simplify and speed the development of new product concepts, Kappa Bioscience developed the K2VITAL® Formulation LookBook.

MARKET-READY PRODUCTS

Over 20 nutraceutical product formats and 150+ market-ready product formulations, each with K2VITAL® vitamin K2 MK-7 as the cornerstone ingredient.

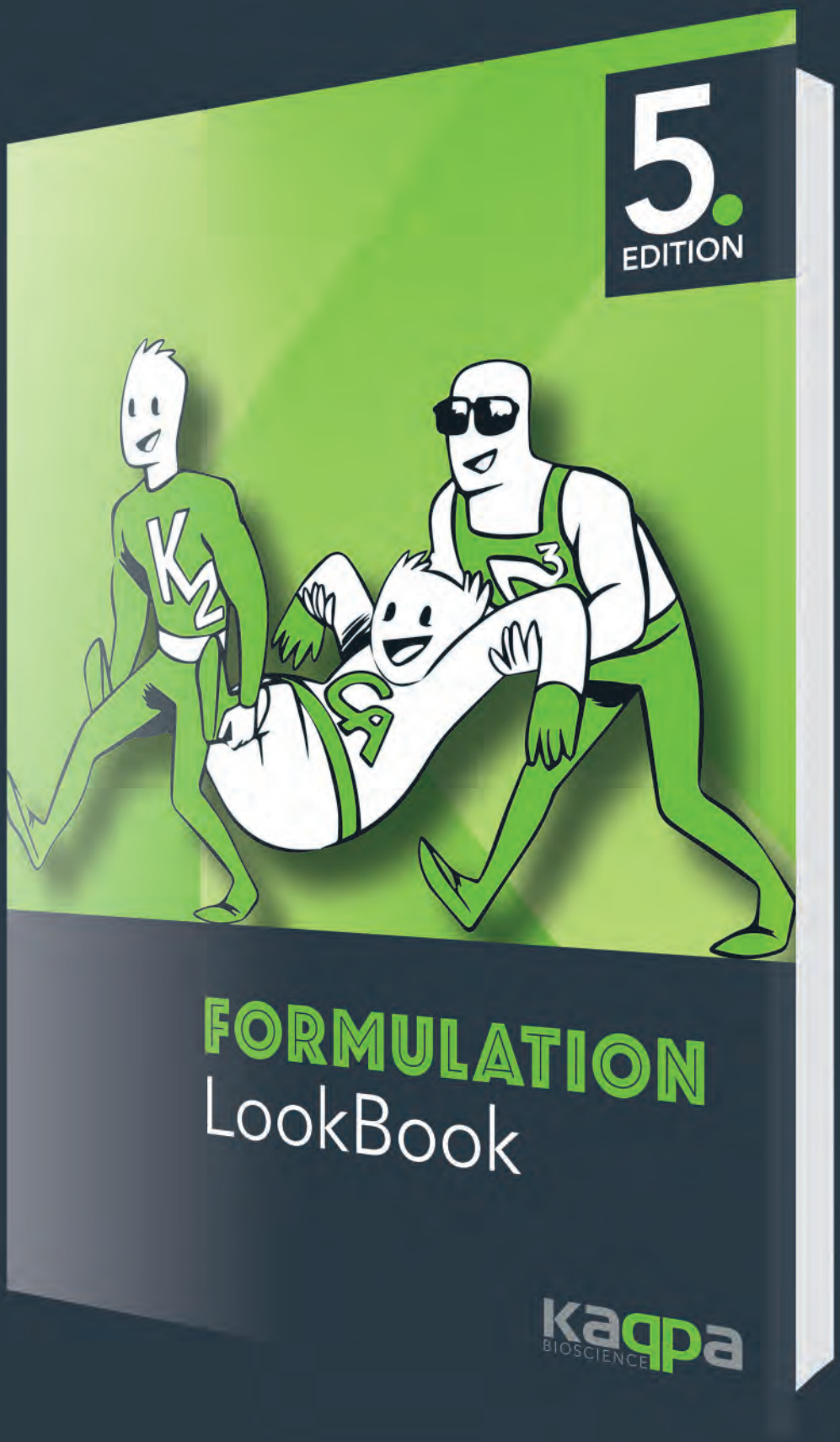
FULL OF INFORMATION

The LookBook is packed with articles, essays, and information on vitamin K2 and its health and commercial benefits.

WITH OVER 100 NEW PRODUCT LAUNCHES EVERY YEAR

The K2VITAL® Formulation LookBook simplifies and accelerates the path of product development for our customers.

Kappa has solved many of the challenges to commercial K2 adoption, and the LookBook offers a clear and actionable path for brands to capitalize on the fastest growing health ingredient worldwide. Arranged as a fully cross-categorized product dossier, each formulation provides a blueprint for end-to-end K2 product creation, whether products are required in bulk, packed, or as a finished product.


5.
EDITION
FORMULATION
LookBook
kappa
BIOSCIENCE

K2VITAL® PURITY & QUALITY

K2VITAL® IS A NORWEGIAN-MADE, EXTREMELY PURE, 99.7% ALL-*TRANS* MK-7.

FACTS

K2VITAL® – Exceptionally pure K2 MK-7

Organic synthesis

The Kappa Bioscience method for the organic synthesis of K2VITAL® starts with flower extracts. The process results in a K2VITAL® molecule that is identical to the MK-7 found in nature.

>99,7% Pure

Kappa's organic synthesis production method typically achieves isomeric purity of >99.7%, with no traces of MK-6.

K2VITAL® benchmark

Compared to minimum standards and regulations, K2VITAL® purity is exceptionally high. So high, in fact, that the USP uses synthetically-produced K2VITAL® MK-7 as the Reference Standard. In effect, all K2 manufacturers, including industrial-fermentation producers, benchmark MK-7 purity against K2VITAL®.

PURE

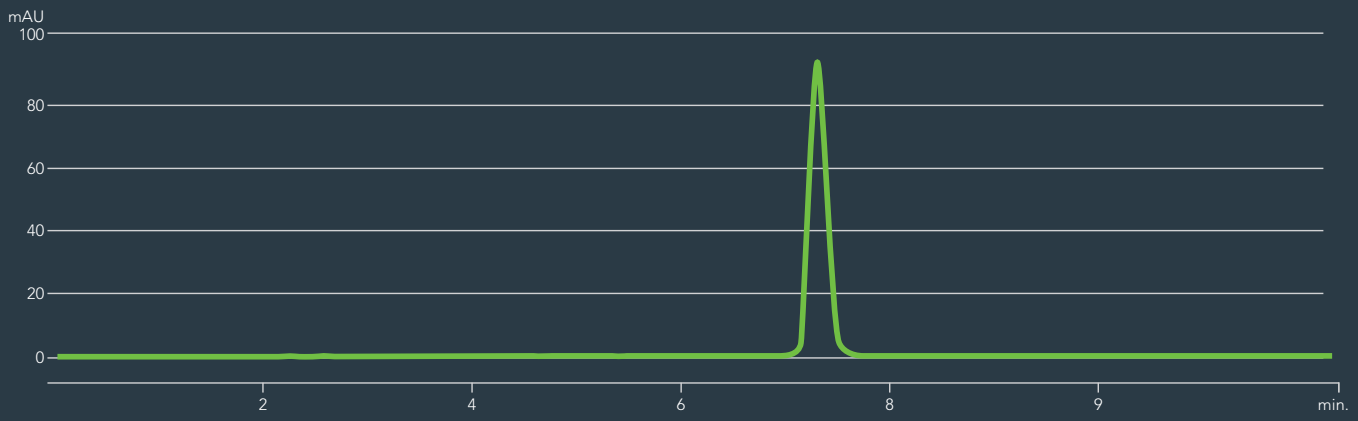
K2VITAL® is virtually free of allowable impurities that may typically be present in inferior quality K2 (primarily *cis* isomers and MK-6, each permitted to a maximum of 2%).

ALLERGEN-FREE

K2VITAL® is allergen-free and free of brownish color and odor retention.

CHROMATOGRAM: PURE K2VITAL® K2 MK-7 REFERENCE STANDARD

(150 MM COLUMN)



Parameter		USP	K2VITAL®
trans-Menaquinone-7	NLT	96.0%	99.0%
cis-Menaquinone-7	NMT	2.0%	0.3%
Menaquinone-6	NMT	2.0%	0.0%
Residue on ignition	NMT	0.2%	0.1%
Arsenic	NMT	2.0 µg/g	0.05 µg/g
Cadmium	NMT	1.0 µg/g	0.01 µg/g
Lead	NMT	3.0 µg/g	0.03 µg/g
Mercury	NMT	0.1 µg/g	0.02 µg/g
Total molds and yeast	NMT	$1x10^2$	$1x10^2$
Salmonella sp.		absent	absent
Staphylococcus aureus		absent	absent
Escherichia coli		absent	absent

K2VITAL®

KAPPA BIOSCIENCE OFFERS ONLY THE HIGHEST PURITY AND QUALITY INGREDIENTS.

THE REFERENCE STANDARD

K2VITAL® Reference Standard is the only standard substance specifically available for analysis of Vitamin K2 MK-7 in dietary supplements, nutraceutical raw materials and finished products. It is a standard that can be used not only for the quantity but also for the *cis/trans* purity assessment of products. The reference standard is nearly 100% pure vitamin K2 MK-7. It is very well characterized for identity and purity.

K2VITAL® LONG SHELF LIFE

K2VITAL® has a long shelf life of 36 months in finished products, which is supported by extensive stability data on both ingredients, the ingredient in formulations and finished consumer products.

APPROVALS

Novel Food (EU), TGA (AUS), sGRAS (USA), Drug registration in India, Kosher and Halal certifications. Based on the self-affirmed GRAS approval, K2VITAL® can be used in conventional food.

K2VITAL® PRODUCTION FOLLOWS GMP, HACCP AND IFS MANUFACTURING AND DISTRIBUTION STANDARDS.

K2VITAL® ANALYSIS

FACTS

Vitamin K2 MK-7: Analytical Methods

Leader in development

Kappa Bioscience has led the development of reliable and valid HPLC methods for MK-7 detection and analysis. Analytical methods enable long-term stability analysis and accurate label claim testing required for R&D, quality control and consumer protection. Kappa also introduced the quality parameter for isometric purity (*cis* and *trans* determination) which describes the degree of bioactivity of the molecule.

The USP monograph

The USP monograph describes MK-7 analytical methods inclusive of the identification, assay and impurities testing for pure MK-7, MK-7 in solid and liquid preparations, and MK-7 in capsules and tablets. Kappa remains involved with the USP to this day regarding method development, the molecule characterization program, and the development of various monographs, including for testing encapsulated MK-7.

MK-7 ANALYSIS

Kappa also developed the validated methodologies for MK-7 analysis used for sGRAS, EFSA Novel Food and TGA/Complimentary Medicine (AU) registration/authorization.

COMMITMENT

Kappa is committed to the development of, and market education about, the analytical methods which provide confidence in MK-7 to manufacturers, brands and consumers.

VALID RESULTS

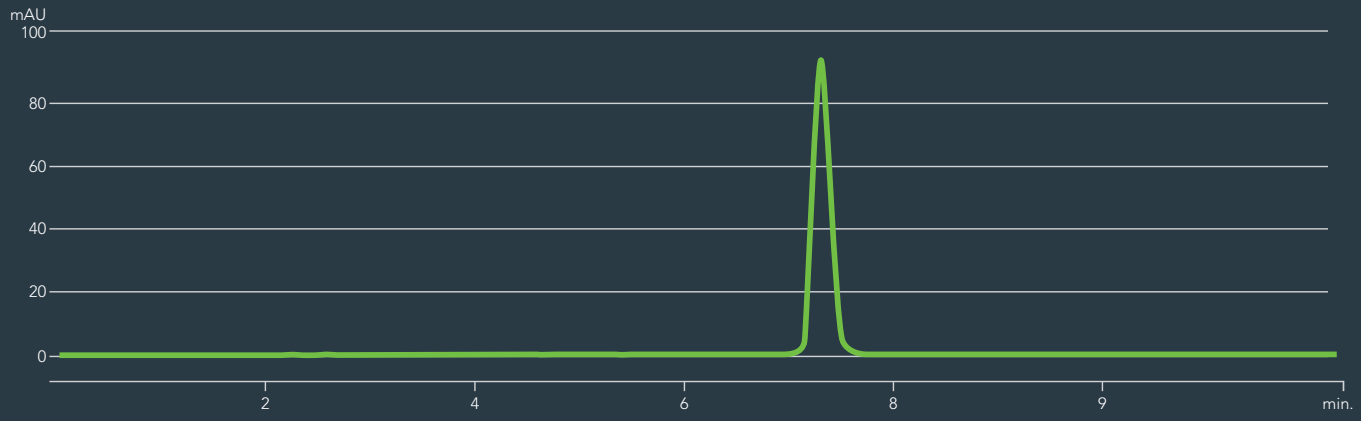
Chromatographic analysis of MK-7 is a necessity in quality determination. The applicability of K2, promotes a range of product formulations/matrixes which affect chromatographic analysis.

THE DELTA METHOD DEVELOPED FOR THE ASSAY OF ENCAPSULATED MK-7 IS NOW IN WIDESPREAD COMMERCIAL USE.

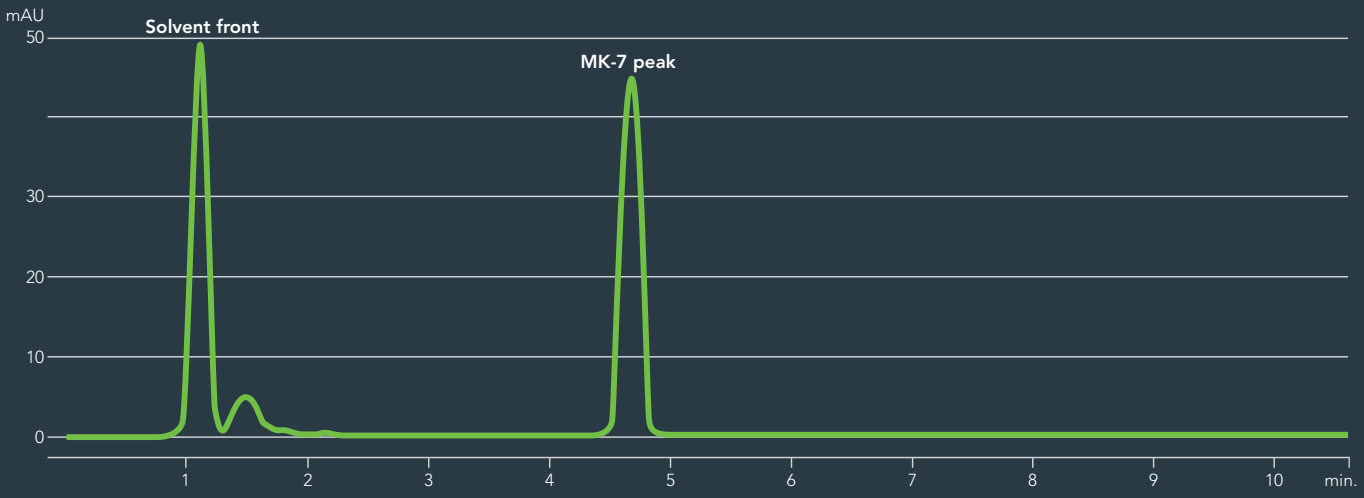
USP INCLUDES METHODS DESCRIBING:

- proper dissolution of the microencapsulation coating to ensure test accuracy
- quantification of MK-7 content in the product
- determination of MK-7 *cis/trans* ratio
- definition of the MK-7 purity standards

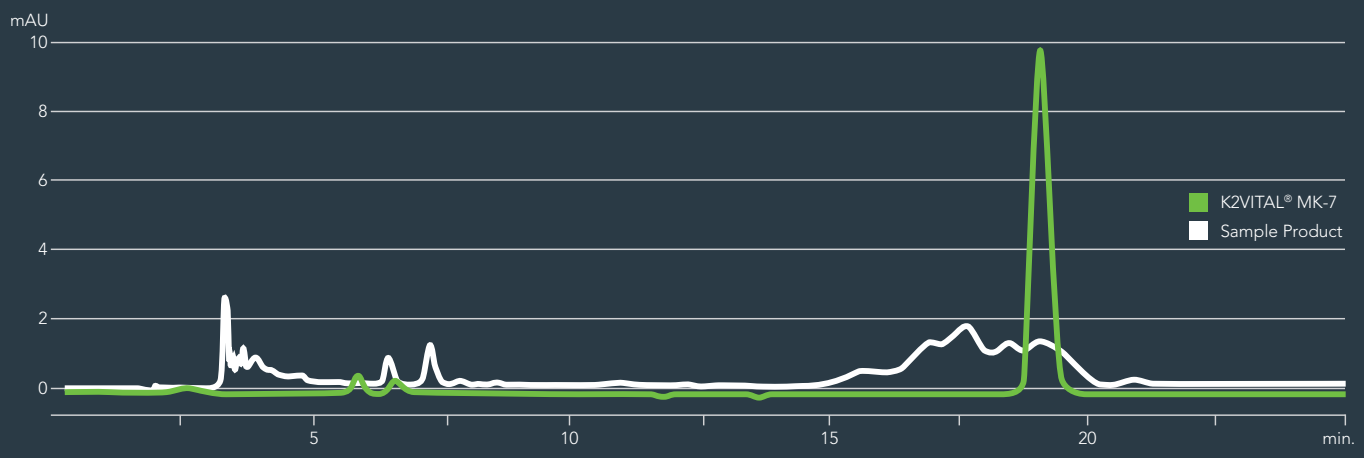
CHROMATOGRAM: PURE K2VITAL® K2 MK-7 REFERENCE STANDARD (150 MM COLUMN)



CHROMATOGRAM: PURE K2VITAL® DELTA (100 MM COLUMN)



CHROMATOGRAM: PURE K2VITAL® K2 MK-7 COMPARED TO LOW QUALITY MK-7: *ISOMERIC PURITY*



CAS

CALCIFIED ATLANTIC SEAWEED®

FACTS

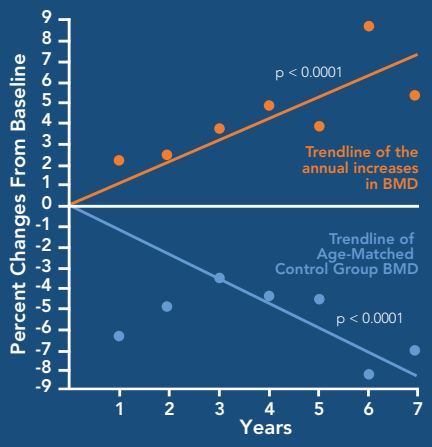
28 bone building elements
A marine mineral complex of 28 essential bone-building elements (including Calcium, Magnesium, Iron and multiple essential trace minerals).

All natural
Calcified Atlantic Seaweed® (CAS) is made from sustainably harvested Atlantic red algae and free of chemicals, additives or solvents.

Competitive and proven
Competitive pricing for mass market applications. Human clinical trials have demonstrated *Lithothamnion* sp. ingredients effectivity in increasing bone mineral density significantly.

CALCIUM SOURCES TYPICALLY ONLY SLOW BONE LOSS

Contrarily to rock-based calcium, **plant-derived calcium has been shown to effectively increase bone mineral density, by up to 1,04% each year, sustained over 7 years.** *(1)*



PLANT-DERIVED CALCIUM

***Lithothamnium calcareum* stores its minerals in a porous structure, which:**

- dramatically increases the surface area
- creates a greater contact surface for the stomach acids to dissolve calcium

VS

CALCIUM FROM LIMESTONE

Calcium carbonate sourced from rocks has a much smaller surface area and is more difficult to dissolve, which:

- leads to a decreased calcium absorption
- causes digestive adverse effects

1: Kaats, G. R., Preuss, H. G., Stohs, S., & Perricone, N. (2016). A 7-year longitudinal trial of the safety and efficacy of a vitamin/mineral enhanced plant-sourced calcium supplement. Journal of the American College of Nutrition, 35(2), 91-99.

WHAT IS IT?

Calcified Atlantic Seaweed® (CAS) is a natural mineral complex, from red algae, rich in calcium, magnesium, iron and several trace minerals. As natural and plant-sourced mineral it is used for various nutritional, nutraceutical and health food applications.

SOURCING

Calcified Atlantic Seaweed® naturally absorbs minerals from the sea during its growth phase. Those minerals calcify to a skeletal structure and mature material settles separately from young and live material on the seabed, where it is harvested sustainably.

PRODUCTION

During production process the Calcified Atlantic Seaweed® is harvested, washed, purified and milled under HACCP and ISO 22000:2005 conditions. Unique treatment ensures lowest microbiological and heavy metal impurities.

WHOLE FOOD STATUS

Calcified Atlantic Seaweed® is categorized as a whole-food product and as such suitable for various food and health food applications. As natural marine calcium source it is produced without chemical additives or solvents and is suitable for vegetarians and vegans.

SUITABLE FOR **VEGETARIANS** AND **VEGANS**

NEW PRODUCT LAUNCHES OF DIETARY SUPPLEMENTS FORMULATED WITH LITHOTHAMNIUM

+161%

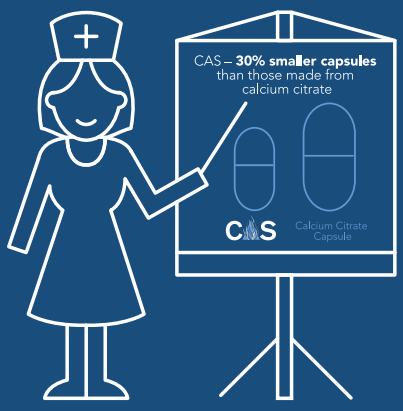
INCREASE SINCE 2015

DEVELOPMENT OF THE CALCIUM SUPPLEMENTS MARKET (NEW PRODUCT LAUNCHES)

–13.6%

DECREASE SINCE 2015

While the calcium supplements market is stagnating, products sourcing natural, plant-based calcium can revitalize brands.



34%

MORE

ELEMENTAL CALCIUM

THAN CALCIUM CITRATE, THE LEADING ORGANIC CALCIUM SOURCE ON THE MARKET

FORMULATE WITH CAS – CALCIFIED ATLANTIC SEAWEED®

- Meets EFSA, FDA and TGA compositional guidelines.
- Available in 2 formats - standard and granulated (directly compressible) to allow a variety of dietary applications.
- With a 32% elemental calcium content, it allows for the use of consumer-friendly tablet/capsule size.

ETHICAL STANDARDS

CONSUMERS EXPECTATIONS

HEALTHY SUPPLEMENTS
Nutritional supplements are consumed by around 80% of the population to maintain good physical and mental condition.

HEALTHY LIFESTYLE
Among younger generations, dietary supplements are more often consumed as lifestyle products for self-optimization.

QUALITY PRODUCTS
Kappa's analyzes confirm that many supplements do not contain the advertised amounts of nutrients. To a minor percentage, it even occurs that products do not contain the labeled nutrients at all.

EVERY YEAR, 23,000 EMERGENCY ROOM VISITS AND 2,000 HOSPITALIZATIONS IN THE USA ARE ASSOCIATED WITH DIETARY SUPPLEMENTS.

The severe forms of product adulteration related to this are caused by substitution or addition of illegal ingredients (such as banned drugs or pharmaceuticals), excessive overage, contaminants, or mislabeling. *(1)*

INDUSTRY PROMISES TO THE CONSUMER

PRIMARY PROMISES
- Label claim: active ingredients in the mentioned amount
- Health or structure-function claim: described and expected health benefit

SECONDARY PROMISES
- Scientific evidence
- Regulatory compliance
- Safety
- Product purity
- Ingredient purity
- Product stability

NEGATIVE NEWS COVERAGE ON DIETARY SUPPLEMENTS reduces the general purchase intent by

30 PERCENT *(2)*

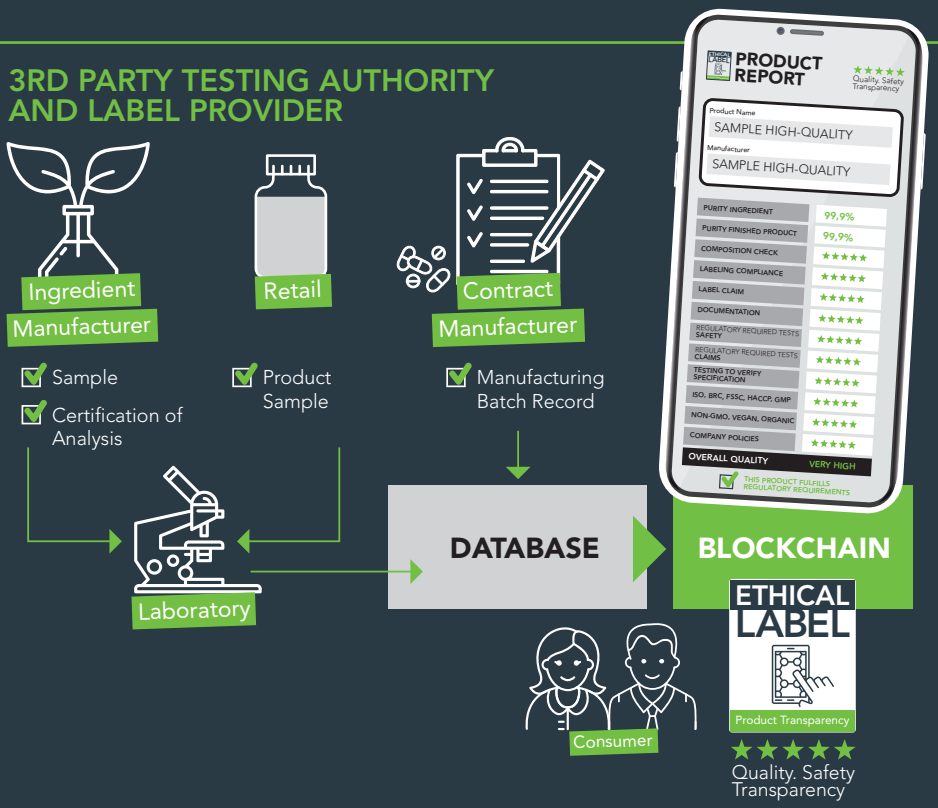
TRUST DATA, NOT WORDS

Whether a dietary supplement fulfills all its promises can only be determined by an independent analysis by a qualified laboratory. In many countries, Food Law has gaps in the number of product tests required and their verification.
Food authorities inspect products from stationary retail much more frequently than those offered online so that counterfeit products in the traditional segment are noticed more quickly. Especially in online trade, 'amateur' brands trade goods without extensive product testing and, therefore, generate a price advantage.

OUTLOOK

Ethics, transparency and sustainability are becoming increasingly important for the dietary supplement industry. The new blockchain technology, in particular, offers unique opportunities for this. Ensuring consumers have a clear view of the quality of a product is easier than ever.

3RD PARTY TESTING AUTHORITY AND LABEL PROVIDER



- The sum of all data can be summarized in a test report and encrypted to the blockchain so that later modifications cannot occur.
- Products can now be provided with a QR code, which enables consumers to access a user-friendly evaluation that offers clear information on product quality, or access this report via a link on the online shop.
- Young generations of consumers, in particular, attach great importance to this form of transparency, which in the future will become a key differentiator and competitive advantage in the industry.
- Kappa works with several industrial partners to create such Ethical Labels, which are expected to be launched in 2022 at the latest.

JÖRG BÜTTINGHAUS, VICE PRESIDENT SALES & MARKETING AT KAPPA BIOSCIENCE

"Kappa operates in what we view as an ethical industry, and we therefore act to best-serve our customers and ensure the sustainability of our market" said Jörg Büttinghaus, Vice President Sales & Marketing at Kappa Bioscience. He continued, "We also feel obligated to challenge black sheep vendors who also target K2 consumers. Ethics outweighs profit when it comes to health, well-being, and safety, and this is not negotiable. Our partners, customers and even competitors who operate transparently and ethically receive our support and gratitude for protecting our market."

REFERENCE:
1. *Geller, A. I., et al. (2015). Emergency department visits for adverse events related to dietary supplements. New England Journal of Medicine, 373(16), 1531-1540.*
2. *https://www.newhope.com/market-data-and-analysis/supplement-industry-tomorrow*

DAILY DOSAGE & OVERAGE

LIGHT

The overdose amount must compensate for the decomposition of vitamin K2 caused by the direct influence of light during the production process. Assuming 1-3 hours of light during production and processing, we recommend the following overdose:

4%: **K2VITAL® DELTA, K2VITAL® MCC Powder**
10%: **K2VITAL® MCT Oil**

HOW DO YOU CALCULATE THE OVERDOSE AMOUNT FOR K2?

LIGHT AND SHELF-LIFE ARE THE TWO KEY FACTORS THAT INFLUENCE VITAMIN K2 OVERDOSE.

SHELF LIFE

The overdose amount must also compensate for the decomposition of vitamin K2 during its minimum shelf. K2VITAL® products normally have a shelf life of 36 months from their date of manufacture.
The precondition for this is proper packaging and storage of the product in closed containers, protected against light.

OVERDOSE RECOMMENDATIONS FOR FERMENTATION-DERIVED K2 AND MICROENCAPSULATED K2VITAL® DELTA WHEN COMBINED WITH OTHER INGREDIENTS IN FORMULATION

	Vitamin K2 derived through fermentation - without microencapsulation	
Ingredient	K2 overdose with a SLED of 12 months	K2 overdose with a SLED of 24months
Calcium carbonate	> 40%	> 70%
Magnesium oxide	Unusable / decomposition in 12 months >98%	
L-arginine	Unusable / decomposition in 12 months >98%	

	K2VITAL® DELTA	
Ingredient	K2 overdose with a SLED of 12 months	K2 overdose with a SLED of 24months
Calcium carbonate	> 4%	> 14%
Magnesium oxide	> 8%	> 20%
L-arginine	> 3%	> 9%

THE SHELF LIFE AND OVERDOSE AMOUNTS ARE DIFFERENT FOR MONO-K2 AND K2 PREPARATIONS IN COMBINATION.

MONO PREPARATIONS

For mono-K2 preparations, with the carrier substances – microcrystalline cellulose (MCC) and/or medium chain triglyceride oil (MCT), no separate overdose is necessary for a 24-month finished product shelf life period. It must, in all cases, be ensured that the finished product is protected against light.

COMBINED PREPARATIONS

K2 in combination with other ingredients can provide superior health benefits. For example, in the field of bone health, staple ingredients include calcium, magnesium, vitamin D3, collagen peptides, zinc and vitamin C. For cardiovascular health, frequent co-ingredients include magnesium, phytosterine, L-arginine, B vitamins, omega-3 concentrates made of fish and krill oil, and a range of medicinal plants. Unfortunately, the stability of vitamin K2 in combination with minerals, herbal extracts, animal or vegetable raw materials, amino acids, and other nutrients is more problematic, compared to mono-K2 preparations. Hence, the stable, microencapsulated K2VITAL® DELTA is the ideal choice for vitamin K2 preparations in combination. The Table on the right, lists the overdose recommendations for fermentation-derived K2 and K2VITAL® DELTA when combined with co-ingredients such as calcium, magnesium or L-arginine (based on current information).

OFFICIAL RECOMMENDED INTAKES FOR VITAMIN K BASED ON LIFE STAGE AND GENDER

Life stage and Gender	1. EU (AI)*	2. US (AI)*	3. AUS / NZ (AI)*
Infants			
0-6 months	★	2.0 µg/day**	2.0 µg/day
7-11 months	10 µg/day**	2.5 µg/day**	2.5 µg/day
Children and Adolescent			
1-3 yrs	12 µg/day	30 µg/day	25 µg/day
4-6 yrs	20 µg/day	55 µg/day	35 µg/day
7-10 yrs	30 µg/day	60 µg/day	45 µg/day
11-14 yrs	45 µg/day	75 µg/day	55 µg/day
15-17 yrs	65 µg/day		
Adults			
Men 19+ yrs	75 µg/day	120 µg/day	75 µg/day
Women 19+ yrs	75 µg/day	90 µg/day	60 µg/day
Pregnancy and Lactation			
14-18 yrs	75 µg/day	75 µg/day	60 µg/day
19-50 yrs	75 µg/day	90 µg/day	60 µg/day

Note
The official recommended doses are based on coagulation of blood and vitamin K1 (Phylloquinone).
* **AI:** Adequate Intake.
★ No specific recommendation has been made in Annex XIII of EU Regulation 1169/2011 regarding the recommended doses of vitamin K in infants, children, pregnant women or lactating women
** For vitamin K1 phylloquinone

AN OVERVIEW OF COMMERCIALLY AVAILABLE K2VITAL® PRODUCTS AND THEIR INGREDIENTS

	K2VITAL® MCT		K2VITAL® MCC	K2VITAL® DELTA	
Concentration	5.00%	1.00%	1.00%	1.00%	0.20%
Form	Oil		Powder	Microencapsulated Powder	
Carrier	Medium-chain Triglyceride Oil		Microcrystalline Cellulose Medium-chain Triglyceride Oil	Sucrose Corn Starch Gum Arabicum Medium-chain Triglyceride Oil Tri-calcium phosphate	
Σ 45 µg MK-7 / kg	1.111.111	222.222	222.222	222.222	44.444
Σ 75 µg MK-7 / kg	666.667	133.333	133.333	133.333	26.667
Σ 90 µg MK-7 / kg	555.556	111.111	111.111	111.111	22.222
Σ 180 µg MK-7 / kg	277.778	55.556	55.556	55.556	11.111
Σ 380 µg MK-7 / kg	131.579	26.316	26.316	26.316	5.263
Commercially available	available	available	available	available	available
Dry powder formulations	✖	✖	(✓)	✓	✓
Oil based liquid formulations	(✓)	(✓)	✖	(✓)	(✓)
Water based liquid formulations	✖	✖	✖	(✓)	(✓)
Soft capsule and pastille formulations	(✓)	(✓)	✖	✓	✓

✓ unrestricted usability (✓) partial usability ✖ inappropriate

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