Original Research Article

Standardized development of an AKG–PQQ–Agaricus bisporus composition for mitochondrial function

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Abstract: Background: Mitochondrial decline is a central feature of biological aging. A formulation combining alpha-ketoglutarate (AKG), pyrroloquinoline quinone (PQQ), and Agaricus bisporus extract may simultaneously support energy metabolism, mitochondrial signaling, and oxidative balance. Methods: Three disclosed embodiments and one comparative formulation were assessed. We retained the core formulation ranges, ingredient-retention values, and comparative mitochondrial indices, and interpreted them together with selected literature on AKG, PQQ, ergothioneine, beta-glucans, and standards-oriented analytical control. Results: Across the three embodiments, AKG retention remained 98.6%-98.9%, PQQ 98.9%-99.2%, and Agaricus extract 98.4%-98.8%, whereas the comparator without Agaricus extract showed lower AKG and PQQ retention at 92.2% and 92.8%. All three embodiments also showed higher membrane-potential indices and lower reactive-oxygen-species indices than the comparator, with Embodiment 3 giving the strongest overall profile. Conclusion: The composition is best understood as a standardized mitochondrial-support system defined by coordinated ingredient design, high retention, and reproducible formulation logic rather than by generic ingredient stacking.

Keywords: AKG; PQQ; agaricus bisporus; ergothioneine; mitochondrial function; formulation standardization; Swiss provenance; traceability

1. Introduction

Interventions intended to support healthy aging are more convincing when they address mitochondrial energetics, biogenesis-related signaling, and oxidative resilience together rather than as isolated targets. The present AKG-PQQ-Agaricus bisporus composition follows that logic by combining a central metabolic intermediate, a signaling-active quinone, and a mushroom-derived protective extract within a restrained excipient framework.

AKG is a core tricarboxylic-acid-cycle metabolite with reported links to metabolic regulation and age-associated physiology [1-2]. PQQ has been associated with CREB/PGC-1alpha-related mitochondrial biogenesis, antioxidant activity, and human redox observations [3-6]. Agaricus bisporus contributes ergothioneine, beta-glucans, and other food-derived bioactives relevant to oxidative protection [7-9]. Taken together, these components support a composition strategy in which metabolic substrate support, mitochondrial signaling, and protective chemistry are integrated within a standardized development window.

2. Materials and methods

The manuscript summarizes the disclosed formulation program and retains the most informative quantitative findings. The composition window comprised AKG 40-65 parts, PQQ disodium salt 0.05-0.5 parts, Agaricus bisporus extract 15-35 parts, and a single-excipient system of 10-20 parts. Three embodiments were compared with a formulation lacking Agaricus extract. Reported outcomes included active-ingredient retention and relative mitochondrial indices. The core embodiment metrics are retained below as the principal table, while surrounding explanation is condensed.

2.1. Core embodiment metrics

Group	Formula highlight	Reported retention	Reported mitochondrial outcome
Embodiment 1	AKG 50; PQQ 0.2; Agaricus extract 29.8; mannitol 20	AKG 98.6%; PQQ 98.9%; extract 98.4%	Higher membrane potential; lower mitochondrial ROS than comparator

Continuation Table.

Group	Formula highlight	Reported retention	Reported mitochondrial outcome
Embodiment 2	AKG 60; PQQ 0.4; Agaricus extract 19.6; lactose 20	AKG 98.7%; PQQ 99.1%; extract 98.5%	Higher membrane potential; lower mitochondrial ROS than comparator
Embodiment 3	AKG 45; PQQ 0.5; Agaricus extract 34.5; MCC 20	AKG 98.9%; PQQ 99.2%; extract 98.8%	Higher membrane potential; lower mitochondrial ROS than comparator
Comparative formulation	No Agaricus extract; multiple excipients	AKG 92.2%; PQQ 92.8%	Lower membrane potential and higher ROS than all three embodiments

3. Results

3.1. Retention and composition robustness

The clearest quantitative signal was the consistently high retention of the three actives across embodiments. AKG retention ranged from 98.6% to 98.9%, PQQ from 98.9% to 99.2%, and Agaricus extract from 98.4% to 98.8%. By contrast, the comparative formulation without Agaricus bisporus extract showed lower retention for AKG and PQQ at 92.2% and 92.8%, respectively. Among the tested versions, Embodiment 3 combined the highest AKG, PQQ, and extract retention, indicating the strongest formulation robustness.

3.2. Comparative mitochondrial indices

The comparative mitochondrial indices followed the same direction. Each embodiment showed a higher normalized membrane-potential index and a lower reactive-oxygen-species index than the comparator. Embodiment 3 again performed best, while the comparative formulation represented the least favorable condition. Although these indices are relative rather than full raw datasets, their internal consistency supports the view that the combined formulation improves mitochondrial status more effectively than a simplified comparator lacking the mushroom-derived component.

4. Discussion

The main strength of the formulation lies in the coordination of three complementary functions. AKG serves as a native metabolic module, PQQ contributes a signaling component linked to mitochondrial biogenesis, and Agaricus bisporus adds ergothioneine- and polysaccharide-associated protective chemistry [1-9]. The composition therefore addresses mitochondrial function through metabolic, signaling, and redox-oriented axes simultaneously rather than through a single mechanistic claim.

A second strength is the manufacturing profile. High retention across three embodiments indicates that the composition is not only biologically plausible but also technically stable under a restrained excipient architecture. For publication purposes, the work is strongest when described in terms of traceability, formulation control, and reproducibility rather than broad longevity rhetoric. That standards-oriented interpretation is consistent with laboratory quality principles centered on valid results, documented methods, and batch discipline [10-13].

The institutional framing should also remain measured. Swiss provenance is meaningful academically when it is translated into method validation, traceability, analytical control, and lot-to-lot consistency rather than unsupported accreditation language. Within that restrained frame, the formulation reads as a standards-oriented development program: The value of the inventor-led design lies not only in ingredient selection but in the effort to define a bounded composition window and to preserve performance across multiple embodiments.

5. Conclusion

The AKG-PQQ-Agaricus bisporus composition can be regarded as a standardized mitochondrial-support platform with clear formulation logic and favorable disclosed performance. High retention across embodiments and coherent comparative mitochondrial indices support the feasibility of combining

metabolic substrate support, mitochondrial signaling, and mushroom-derived protective bioactives in a single system. Its strongest scientific presentation therefore rests on reproducible design, quantified retention, and standards-oriented development.

About the author

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