International Journal of Nutritional Sciences

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Editorial

Nutrition and Male Reproduction: Nutrients Directly Affect Sperm Performance

De Amicis F[1,2], Santoro M[2], Gervasi S[3] and Aquila S[1,2]*

[1]Department of Pharmacy and Sciences of Health and Nutrition, University of Calabria, Italy

[2]Department of Nutrition, University of Calabria, Italy

[3]Università degli Studi "Magna Graecia" di Catanzaro, Italy

***Corresponding author:** Aquila Saveria, Department of Pharmacy and Sciences of Health and Nutrition, University of Calabria - Arcavacata di Rende (Cosenza) 87036 – Italy

Received: August 24, 2018; **Accepted:** August 30, 2018; **Published:** September 06, 2018

Keywords

Human ejaculated spermatozoa; Male fertility

Editorial

Infertility is defined by the World Health Organization (WHO) and the American Fertility Society, as for couple not conceiving after 12-24 months of regular and unprotected sexual intercourse [1]. The incidence of infertility tends to increase due to various factors such as exposure to chemical agents, environmental pollution, smoking, eating habits and high age at the time of marriage. Infertility can be of female origin (about 40%), of male origin (about 40%), of the couple (about 20%) or idiopathic (10%). Male infertility has shown a significant increase, with a sperm count declined by 50 to 60% over the past decades [2], indicating that it is a global health problem. In order to improve reproductive performance in humans, molecules that can enhance semen parameters are the main focus of the latest findings. Studies on the relationship between nutrition and male fertility has emerged over the last decade since nutrition is a key area of interest and potential non-pharmacologic intervention for human infertility. Nutrition and especially energy metabolism influence reproductive function. In fact, when the energy needs are impaired as in case of both under and over-nutrition, the onset of puberty is delayed and gonads disorders may occur. Several studies reported associations between individual metabolic disturbances and various indicators of male fertility. However, the mechanisms underlying the relationship between nutrition, energy metabolism and reproductive function are poorly understood yet. The reproductive axis (hypothalamus, pituitary and gonad) appears to have a number of "nutrient sensing" mechanisms that may link nutrient status and fertility. Furthermore, nutrients (glucose, fatty acids, amino acids) and metabolic hormones including insulin/IGF-1 and adipokines are able to affect the functioning of reproductive cells not only at the central levels (hypothalamus–pituitary) but also at the gonad level. Epidemiological/observational studies provide a comprehensive analysis of the associations between diet or nutrients intake and the risk of infertility, suggesting that diet modifications may be useful in modulating male fertility. Several studies suggest that male adherence to a healthy diet ameliorates semen quality and fecund ability rates. Diets favoring seafood, poultry, whole grains, fruits, low-fat dairy, skimmed milk and vegetables are related to better semen quality in men. Some nutrients more than others such as omega-3 fatty acids, antioxidants and some vitamins, were positively associated with several sperm parameters [3]. Recently, we investigated the effects of promising nutrients directly on ejaculated sperm with the aim of ameliorate sperm performance since their defective activity has been identified as the largest cause of infertility. For example, the 1alpha, 25-Dihydroxyvitamin D3 (the active metabolite of vitamin D3) acting through its specific receptor the VDR, revealed an unexpected significance on the acquisition of fertilizing ability by sperm [4,5]. The all-*trans* Retinoic Acid (the active form of vitamin A) through the Retinoic Acid Receptor α (RARα), induced sperm survival, capacitation and metabolism [6,7]. The epigallocatechin gallate, a green tea polyphenol, through the Estrogen Receptor β (ERβ), was able to induce sperm activities [8]. Myricetin, a natural flavonoid, potentiates sperm functions and the mechanism of action involves the Estrogen Receptor β (ERβ) [9]. Collectively, the effects of these nutrients depended on the concentrations used. Interestingly, the mechanism of action of these nutrients involved nuclear receptors, some of which were found to be present in sperm regulating cellular processes through their non-genomic action since sperm to date is considered to be transcriptional inactive. In fact, sperm functionalities need to be rapidly activated to accommodate dynamic changes in the surrounding milieu. The sperm energy management is also an intriguing issue and it appears that this cell can regulate its own metabolism independently by the systemic regulation [10,11]. Our previous studies demonstrated that the substances which induced capacitation have the effect to reduce the energy stored while concomitantly some enzymatic activities related to the energy expenditure increased [12-15]. It may be generalized that uncapacitated sperm is associable with an anabolic metabolism in order to store energy which will be spent during capacitation when energy expenditure increases to meet the remarkable changes associated with this process and thus implying a catabolic metabolism. Worth of note, all of the nutrients we tested were able to induce the metabolic reprogramming which characterizes the switch from uncapacitated to capacitated status.

A complete picture of the role of nutrition and nutrients on fertility is far from complete, thus, a greater understanding of such interactions is required. Sperm treatment with these nutrients could be indeed effective and beneficial during semen preparation for *in vitro* fertilization procedures. The positive effects of these treatments on sperm functionality could be of great help for all those couples who have difficulty conceiving a child in a natural way. It is therefore crucial to test new nutrients to prevent or cure male infertility.

Citation: De Amicis F, Santoro M, Gervasi S and Aquila S. Nutrition and Male Reproduction: Nutrients Directly Affect Sperm Performance. Int J Nutr Sci. 2018; 3(2): 1025.

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Int J Nutr Sci - Volume 3 Issue 2 - 2018
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