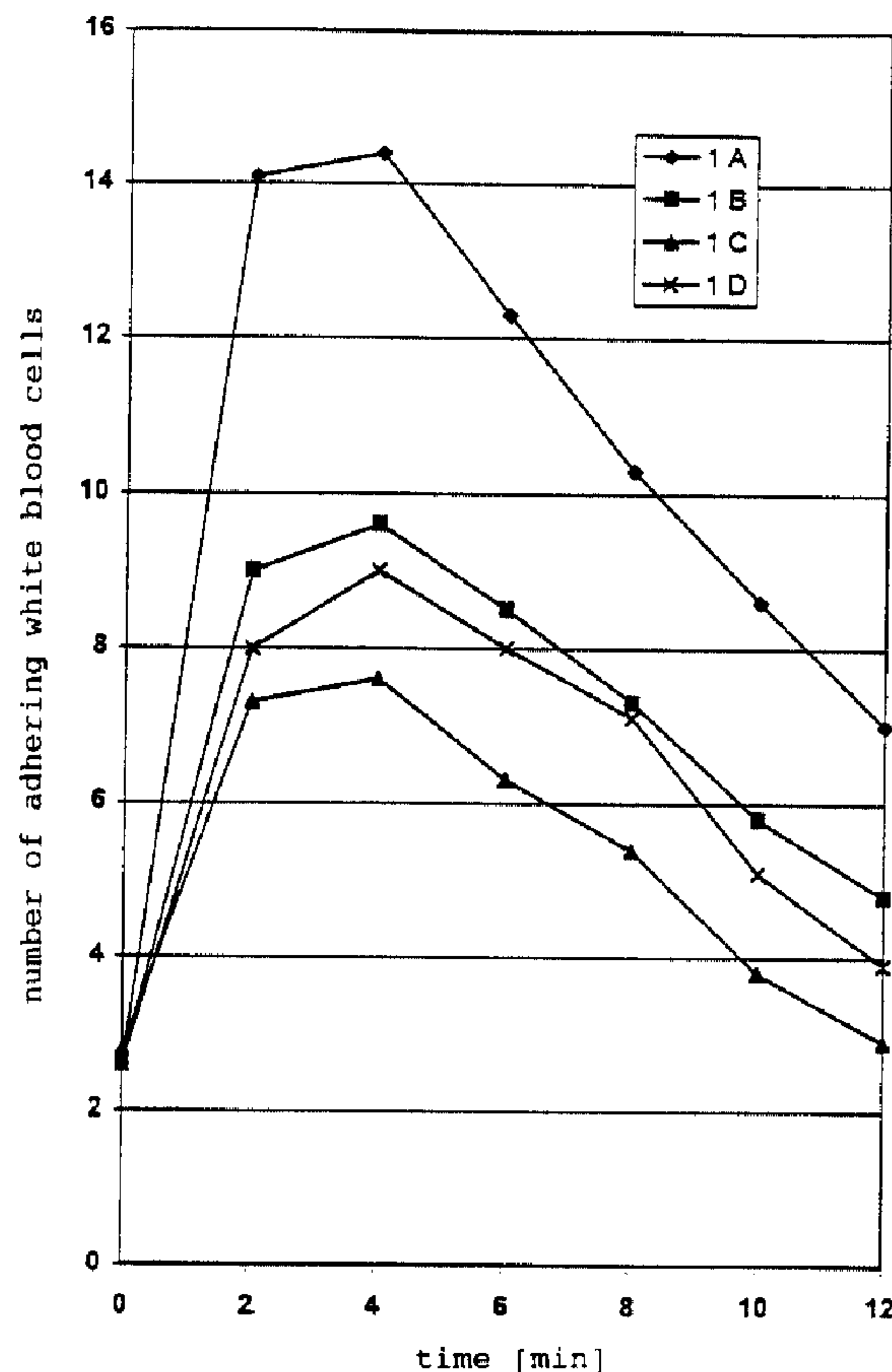




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(71) Demandeur/Applicant:
H.F. & PH.F. REEMTSMA GMBH, DE
(72) Inventeurs/Inventors:
SEIDEL, HENNING, DE;
ROPER, WOLFRAM, DE;
RAHN, WERNER, DE
(74) Agent: BERESKIN & PARR

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(57) **Abrégé/Abstract:**

The invention relates to smokable products such as filter cigarettes, filter cigarillos or cigars with filters which are provided with a gaseous phase active filter and/or a gaseous phase active cigarette paper and/or one or more other components with a content

(57) **Abrégé(suite)/Abstract(continued):**

in gaseous phase active substances that are accessible to the main stream of smoke and to which antioxidant substances have been added.

Abstract

The present invention relates to smokable products, such as filter cigarettes, filter cigarillos or filtered cigars, which comprise a filter which is active in the gas phase and/or cigarette paper which is active in the gas phase and/or one or more other components accessible to the main smoke stream with an addition of substances which are active in the gas phase, and which are provided with an addition of substances having an antioxidative action.

Smokable product

The present invention relates to smokable products, such as filter cigarettes, filter cigarillos or filtered cigars, which comprise a filter which is active in the gas phase and/or cigarette paper which is active in the gas phase and/or one or more other components which are accessible to the main smoke stream and have an addition of substances which are active in the gas phase, and which are provided with an addition of substances having an antioxidative action.

Various systems are chosen to reduce the risk potential of smokable tobacco products. One of the best known is, for example, the concept of so-called "light" or "ultra-light" cigarettes. By means of highly retentive filters in combination with a correspondingly matched filter ventilation, these cigarettes reduce both the particle phase and the gas phase of their so-called main smoke stream and therefore its risk potential overall.

Filter systems which have embedded substances which are active in the gas phase, such as active charcoal, and specifically reduce the gas phase of cigarillos or cigarettes are furthermore known. Such filter cigarettes are described e.g. in DE-PS 41 05 500 C1 or EP-PS 0 558 166 B1.

DE-PS 44 16 101 C2 furthermore discloses smokable tobacco goods which comprise antioxidative naturally occurring substances to reduce the mutagenic potential of tobacco smoke.

However, none of the abovementioned proposed solutions known to date shows the reduction, and optionally even compensation, of the undesirable influence of tobacco smoke on the impairment of the microcirculation of the blood circulation.

The distribution of blood into tiny blood vessels - the microcirculation - is functionally the

most important part of the blood circulation. Diffusion of oxygen, nutrients and metabolism products between blood and tissue cells takes place here. There are wide differences between the microcirculation and the macrocirculation in the arteries and veins. In the tiny blood vessels (capillaries, arterioles and venules) blood cells and blood plasma more or less demix, and combine again in the veins only after flowing through the microvessel network. The microcirculation is adapted to the requirements of the particular tissue by a number of regulatory mechanisms, and the functional state thereof is determined by the flow properties and flow conditions of the blood.

The distribution of blood cells in the microvessels is of importance both for the "nutrition" of adjacent tissue cells (red blood cells) and for the immune reaction (white blood cells).

During smoking, the functional state of the microcirculation in the mucous membrane of the mouth - a representative organ region - and other organs or organ regions is changed temporarily. The mucous membrane of the mouth, with the first contact with tobacco smoke - and also with other substances which are taken up via the respiratory or digestive tract - represents a particularly efficient organ region here for perception of and defence against environmental influences. During smoking of a cigarette and some minutes thereafter, the distribution of blood in the microvessels is limited somewhat, the flow intensity in the small blood vessels drops, and an increasing number of white blood cells appear in the vessels, temporarily adhering to the vessel walls (initiation of an immune reaction).

In healthy persons, the short-term restrictions on blood distribution and blood flow by smoking can be compensated by endogenous regulatory mechanisms and are therefore not particularly unacceptable. In "normal" daily life, the microcirculation is also sometimes subject to considerably wider variations. The effects of smoking desired by the smoker moreover includes the slight increase in blood pressure caused by the vascular constrictions.

The behaviour of the white blood cells during smoking (i.e. concentration thereof and adhesion to the vessel walls) is a normal reaction of the endogenous defence system which perceives cigarette smoke as an interference factor. Such immune reactions guarantee protection of the organism against influences of the outside world. The acute changes on the basis of the white blood cells observed during smoking are tolerated by a normal immune

system. However, when evaluating the possible consequences of smoking, the extent and possible secondary reactions (inflammation reactions) are to be taken into account. It should be of advantage if e.g. a cigarette impairs the local microcirculation and defence situation as little as possible.

The object of the present invention is therefore to provide smokable products of which the main smoke stream (MSS) and secondary smoke stream (SSS) impairs or reduces the microcirculation - especially in the mucous membrane of the mouth - significantly less than is the case with conventional products with comparable nicotine and condensate values, while simultaneously ensuring acceptance of the taste, i.e. without adversely influencing the taste properties of the products.

The object is achieved according to the invention by a smokable product, such as e.g. a filter cigarette, a filter cigarillo or a filtered cigar, which

- a) comprises a filter which is active in the gas phase and/or cigarette paper which is active in the gas phase and/or one or more other components accessible to the main smoke stream comprise an addition of substances which are active in the gas phase, and
- b) of which the strand of tobacco and/or another smokable material and/or other components accessible to the main smoke stream is/are provided with an addition of substances having an antioxidative action.

In the context of the present invention, "components accessible to the main smoke stream" are understood as meaning those constituents of smokable products, such as cigarettes, cigarillos or cigars, which, on smoking down, form substances which pass completely or in part into the main smoke stream, or other components which are eluted into the main smoke stream during smoking.

In the context of the present invention it has been found, surprisingly, that an abundance of positive effects is achieved by the fundamental idea of the invention, that is to say interference-free, i.e. not mutually obstructive, combination of two in themselves opposing mechanisms. The considerable depletion in the relevant part of the smoke - the gas phase - of undesirable substances with simultaneous concentration in the other relevant part of the smoke - the

particle phase - of naturally occurring substances having a protective action result in, side by side,

- reduction in the cytotoxicity by charcoal filters (Fundamental and Applied Toxicology 39, 11-17 (1997))
- reduction in the mutagenicity (DE-PS 4 16 101 C2)
- reduction in the impairment of the microcirculation both by the main smoke stream and by the secondary smoke stream

and also additionally an

- improvement in the taste of the main smoke stream,
- improvement in the smell of the secondary smoke stream

to a surprisingly high degree.

On the basis of the fundamental idea of the invention - depletion in the gas phase with simultaneous concentration in the particle phase - in principle all design parameters known or familiar to the expert (i.e. use of different filter types, use of various tobaccos or tobacco mixtures, use of different tobacco strand wrappings, choice of components which are to be charged with substances having an antioxidative action etc.) can be used to design the cigarettes and cigarillos according to the invention and variants thereof in, for example, the known value segments such as full flavour, medium, lights and ultra-lights.

- The invention thus relates to a smokable product which comprises a filter which is active in the gas phase and/or cigarette paper which is active in the gas phase and of which the strand of tobacco and/or another smokable material and/or other components accessible to the main smoke stream is/are provided with an addition of substances having an antioxidative action.

The product comprises either a tobacco strand wrapped with cigarette paper or a tobacco

strand wrapped with nonwoven paper and cigarette paper, the permeability to air of the cigarette paper being 10 to 100 Coresta units (CU), preferably 20 to 60 CU, and the permeability to air of the nonwoven paper being 4,000 to 60,000 CU. Alternatively, the product comprises either a tobacco strand wrapped with naturally occurring and/or reconstituted tobacco or a tobacco strand wrapped with at least two layers of reconstituted tobacco or foil tobacco, the permeability to air of one layer of film tobacco being either ≤ 1 CU ("impermeable to air") or 5 to 100 CU ("permeable to air"), preferably 40 to 80 CU.

In the context of the present invention, "filter which is active in the gas phase" is understood as meaning a filter which comprises 5 to 65 wt.%, preferably 20 to 50 wt.%, particularly preferably 30 wt.% of a porous material of large (internal) surface area which is active in the gas phase.

Preferably, the filter has a filter ventilation zone running in the circumferential direction in the part on the mouth side, and the degree of filter ventilation is 5 to 95%, preferably 25 to 75%. However, the filter can also comprise a means known to the expert for introducing ventilation air into the filter at another or any desired point. For example, both the filter wrapping papers and the tipping can be in part or completely a perforated zone or naturally porous.

According to a particular embodiment, the filter which is active in the gas phase is a double filter, but it can also be e.g. a mono- or multifilter, the multifilter being any desired combination of filters from the group consisting of compartment filters, interspersed filters, monoblock filters and/or core filters. In the case of a double filter, the part on the strand side - and in the case of monofilters the entire part - preferably consists of a tissue paper which comprises 5 to 65 wt.%, preferably 20 to 50 wt.%, and particularly preferably 30 wt.% of such a material which has a large surface area and is active in the gas phase.

According to a particular embodiment, the smokable product is either a filter cigarette with a tobacco strand surrounded by a cigarette paper, or a filter cigarillo (without cigarette paper) or a filtered cigar, the tobacco strand being surrounded by a covering leaf or a covering and enveloping leaf of naturally occurring or reconstituted tobacco.

A preferred filter - preferably a double filter - has a filter ventilation zone running in the

circumferential direction in the part on the mouth side, the tissue paper of the filter part on the strand side being a very voluminous paper. According to this embodiment, the permeability to air of the cigarette paper is 10 to 100 Coresta units (CU), preferably 20 to 60 CU, and the degree of filter ventilation is 5 to 95%, preferably 25 to 75%.

Preferably, the tissue paper (in the case of a double filter the tissue paper of the filter part on the strand side) comprises 30 wt.% of a material of large surface area. The part of the filter on the strand side is, in particular, a core filter with a core of tissue paper surrounded by a jacket of material which is virtually impermeable to the main smoke stream.

According to the invention, the filter which is active in the gas phase comprises a material which has a large surface area, is active in the gas phase and is a porous material of large (internal) surface area from the group consisting of active charcoal, aluminium oxide, aluminium hydroxide, bentonite, cellulose, kieselguhr, ion exchangers, light metal salts, sepiolite, molecular sieves, silica gels, aluminas and zeolites or combinations thereof, active charcoal, sepiolite and silica gel being particularly preferred as substances which are active in the gas phase.

Commercially available compartment filters (3-compartment filters) in which the centrally located compartment to be filled with the abovementioned material of large surface area which is active in the gas phase can vary in size according to the amount of gas phase to be absorbed can be employed in construction of the filter. As a rule amounts by weight of 25 mg to 250 g of the abovementioned materials of large surface area are employed here, the concrete amounts employed varying within the weight range mentioned according to the particle size, bulk density and degree of ventilation of the preferably ventilated filters. The highest possible degree of filling of the compartment is important here. Surprisingly, it has been found that even if relatively large amounts of substance which is active in the gas phase are employed, e.g. 100 mg of an active charcoal conventionally used, the adverse taste effect known to the expert ("off taste", "off flavour") can be compensated or overcompensated by strand additives having an antioxidative action, such as e.g. tocopherol acetate, while simultaneously producing a particularly good taste.

Other filter constructions with material which is active in the gas phase which are known per

se can furthermore be employed, thus e.g. interspersed filters (for example in the case of a double filter the filter section on the strand side is preferably provided with embedded amounts, e.g. of granular materials which are active in the gas phase in amounts of 10 to 150 mg), monoblock filters (the material which is active in the gas phase, preferably active charcoal, is glued in places with, for example, polyolefins in the form of a cylindrical body), multifilters, which comprise at least two, optionally different, available forms of the material which is active in the gas phase - which can also be different - in addition to the filter sections which retain the particle phase, and also core filters, in which either the jacket or the core comprises or consists of material which is active in the gas phase, and alternatively core filters in which both the jacket and the core comprise or consist of material which is active in the gas phase but different in each case, and further filter constructions of the type mentioned which are known to the expert. In this connection, the filters can be ventilated by channels and/or have a recess filter section on the mouth side and/or a core filter on the mouth side. All the filter constructions mentioned which comprise material which is active in the gas phase can themselves comprise, both in the material which is active in the gas phase and in the material which retains the particle phase, the substances according to the invention which have an antioxidative action, and can additionally be provided with further permissible additives, such as aromas, fragrances, conventional filter hardeners and other additives permitted for cigarettes and cigarillos. It goes without saying that the filter constructions mentioned which comprise material which is active in the gas phase are also provided with conventional filter material which retains the particle phase or additional filter sections which retain the particle phase, in particular with cellulose, cellulose acetate and the filter materials which retain the particle phase and are described in DE-PS 197 53 193 and DE-PS 197 53 195 and in DE-OS 42 05 658.

In the context of the present invention, it has proved advantageous to employ a material of large surface area which has a particle size of 2 mm or less, preferably 15 μm to 2 mm, or according to a particular embodiment less than 15 μm , and has an internal specific surface area in the range from 50 m^2/g to 2,000 m^2/g . This applies both to filter cigarettes and to the filtered cigarillos or cigars according to the invention.

In the context of the present invention, "cigarette paper which is active in the gas phase" is

understood as meaning a cigarette paper which comprises at least one of the abovementioned materials of large surface area which is active in the gas phase. Thus, for example, the cigarette paper can be provided with very fine-particled silica gels, zeolites, aluminium oxides etc. Alternatively, the cigarette paper which is active in the gas phase can be, for example, a two-layered tobacco strand wrapping which is provided with very finely ground active charcoal in a manner known per se (Carbon Filler Paper Innerliner for Cigarettes and Cigars; Ecusta Paper Division OLIN; Research & Development Dept. report; August 27, 1973).

An embodiment of the invention which is preferred according to the invention is therefore a filter cigarette, the tobacco strand of which is wrapped with two layers of cigarette paper, the inner layer comprising a cigarette paper of low permeability to air which reduces the secondary smoke stream and the outer layer comprising an aromatized cigarette paper having a permeability to air of 20 to 100 CU, preferably 40 to 80 CU.

The substances which are added to the tobacco and/or other smokable materials and have an antioxidative action are preferably chosen from the group consisting of ascorbic acid, β -carotene, retinol, tocopherol (in particular α -tocopherol), its derivatives (in particular tocopherol acetate) and precursors, eugenol, jasminaldehyde, cinnamon, cinnamon extract, (crude) coffee, (crude) coffee extract, coffeic acid methyl ester, coffeic acid ethyl ester, ferulic acid methyl ester, ferulic acid ethyl ester, umbelliferone scopoletin and curcumin, it being possible for the substances to be added to the tobacco either individually or in combination with one another. According to a particularly preferred embodiment of the invention, the addition comprises or includes α -tocopherol, tocopherol acetate (ToAc) and/or tocopherol succinate.

According to the invention, the tobacco strand is provided with an addition of more than 0.1 wt.% to 5 wt.% (based on the amount of tobacco), preferably more than 0.5 wt.% to 4 wt.%, and particularly preferably 1 wt.% to 2.5 wt.% of substances having an antioxidative action. If the addition comprises more than one substance having an antioxidative action, according to a particular embodiment of the invention the amount thereof added to the tobacco is in each case at least 0.25 wt.% to 1.25 wt.%.

According to the fundamental idea of the invention - depletion in the gas phase with

simultaneous concentration in the particle phase - not only substances having an antioxidative action but additionally also the materials mentioned of large surface area which are active in the gas phase can be added to the components of the smokable products which are accessible to the main smoke stream. This addition of substances which are active in the gas phase can optionally be combined with a filter which is active in the gas phase and/or a cigarette paper which is active in the gas phase or replace the filter which is active in the gas phase and/or the cigarette paper which is active in the gas phase, depending on the nature of the smokable product.

The filter cigarette of the present invention has a tobacco strand surrounded by a cigarette paper. Instead of tobacco, other smokable materials, including tobacco-containing mixtures of these other materials, can also be used in the products according to the invention. Thus, for example, "Kretek" cigarettes with an addition of up to 50 wt.% of smokable spices, or pure tobacco-free plant cigarettes are also included according to the invention. In the following, reference is made exclusively to "tobacco", but this term is intended always to include the other smokable materials mentioned.

The tobaccos or tobacco mixtures employed either completely or predominantly comprise expanded or non-expanded lamina tobacco, but can also comprise so-called industrial tobaccos, such as rib cut or foil tobacco (FT). In a preferred embodiment, the substances according to the invention which have an antioxidative action are advantageously incorporated directly into the foil tobacco in a manner known to the expert. Amounts by weight of them of 0.1% to 10%, preferably 1% to 7%, and particularly preferably 2% to 4% are incorporated into the foil tobacco, depending on the physical nature and technically relevant properties of the substances according to the invention having an antioxidative action and the desired intended use. Such foil tobaccos are particularly suitable for use in cigarillos and cigars, for example as a covering and/or enveloping leaf, but can also be used directly as (smokable) - tobaccos or added in the form of a coarse or fine cut to the tobacco mixtures for cigarillos, cigars or cigarettes.

Preferred tobacco mixtures which can be employed for cigarettes are:

- pure Virginia mixtures ("pale")

- pale mixtures with an Orient content
- so-called American Blend (AB) mixtures
- dark mixtures (air cured).

These mixtures can also comprise industrial tobaccos (rib, FT), it being possible for the particular lamina (leaf tobacco) contents to be expanded completely or in part. In all cases, the mixtures and the smoking products according to the invention to be produced therefrom comprise the substances having an antioxidative action which are claimed. AB mixtures are often employed, e.g. according to the following mixture recipe range which is preferred according to the invention:

- a) 20 to 40% air cured tobaccos
- b) 20 to 70% Virginia tobaccos
- c) 5 to 20% Orient tobaccos
- d) 0 to 25% foil tobacco
- e) 5 to 15% rib cut
- f) 0.1 to 5% naturally occurring substances having an antioxidative action,

and additionally conventional additives, such as, for example, "casing" and "flavour".

Although American Blend (AB) mixtures are preferably employed, in special cases, i.e. in respect of the taste position of the product, deviations can be made or other tobacco mixtures from "pale" to "dark" can be employed.

For cigarillos and cigars, "dark" tobacco mixtures based on air cured tobaccos, the naturally occurring substances having an antioxidative action and further tobaccos familiar to the expert and the conventional additives are rather employed. In the case of the approximately cigarette-shaped filter cigarillos in particular, a part amount, and optionally the total amount of the naturally occurring substances having an antioxidative action is preferably added to the enveloping leaf of tobacco foil.

In principle, the substances having an antioxidative action can not only be added to the tobacco but also be incorporated into or used to treat individual components of the tobacco products which are accessible to the main smoke stream, such as filters, wrapping papers,

wrapping tobaccos, carrier substances, seam size etc., in a manner known per se. If the substances having an antioxidative action are incorporated into the cigarette paper or into the size of the cigarette seam, the preferred amounts are more than 0.1 wt.% to 20 wt.%, amounts of 1 to 7.5 wt.% being particularly preferred. In addition to the abovementioned substances having an antioxidative action, the tobacco strand can be provided with further additions of auxiliaries, fillers and aroma substances (additives), in a manner which is likewise known per se.

For the addition of relatively large amounts of substances having an antioxidative action to the tobacco mixture, in particular for the addition of tocopherol acetate, it has proved advantageous to provide the tobacco strand with a double-layered cigarette strand wrapping (nonwoven paper), the inner layer comprising highly porous wrapping paper having a permeability to air of 4,000 to 60,000 CU and the outer layer comprising cigarette paper which is conventional per se. Any migration effects of the liquid additive from the tobacco mixture of the cigarette to the outer cigarette paper, e.g. characterized by an undesirable formation of specks, are advantageously prevented or at least reduced as a result. Alternatively, smaller amounts of the substances having an antioxidative action which are added according to the invention can also be applied in encapsulated form, in accordance with DE-PS 42 44 467, to the inner, highly porous wrapping paper.

Other multi-layered tobacco strand wrapping combinations can also be employed. For example, special cigarette papers for the most diverse purposes known to the expert can be combined or employed with the inner, highly porous wrapping paper, such as, for example, aromatized papers (e.g. according to EP 0 294 972), papers which reduce the secondary smoke stream (e.g. according to EP 0 251 254 or EP 0 338 156) or papers for self-extinguishing cigarettes (e.g. according to EP 0 375 844). These cigarette papers can of course also be used alone, i.e. in one layer - especially if relatively small amounts of substances having an antioxidative action are employed for the smoking goods according to the invention. This possibility also exists with foil tobacco wrappings, in particular with cigarillos. Combinations of tobacco strand wrapping combinations which are preferred according to the invention are shown in Tab. 1.

Tab. 1

Multilayered tobacco strand wrapping combinations		
Inner wrapping	Middle wrapping	Outer wrapping
foil tobacco (enveloping)	FT "impermeable to air" (covering leaf)	conventional cigarette paper (sheath)
highly porous paper	---	natural (tobacco) covering leaf
highly porous foil tobacco	---	natural (tobacco) covering leaf
synthetic enveloping leaf (paper)	foil tobacco (covering leaf)	conventional cigarette paper (sheath)
highly porous paper	---	conventional cigarette paper
SSS-reducing cigarette paper	---	aromatized cigarette paper
highly porous paper	---	aromatized cigarette paper
highly porous paper	---	self-extinguishing cigarette paper
porous foil tobacco	---	any desired cigarette paper
highly porous paper	SSS-reducing cigarette paper	aromatized cigarette paper
any desired paper	highly porous paper	any desired cigarette paper
paper containing active charcoal	---	any desired cigarette paper

In Tab. 1, the first (top) block relates to the filtered cigarillos and cigars according to the invention and the second (bottom) block relates to the filter cigarettes according to the invention. In principle, the wrappings listed can be exchanged or combined amongst themselves (within a row) and with one another (different rows) in an appropriate manner.

A filter cigarillo, e.g. an approximately cigarette-shaped filter cigarillo, which is provided with an enveloping leaf of foil tobacco which is permeable to air or impermeable to air and a covering leaf of naturally occurring tobacco and has a compartment filter, the central compartment of which is filled with active charcoal, is furthermore included according to the invention.

According to a particularly preferred embodiment of the invention, the filter used is a filter according to PCT/EP97/06390 which is active in the gas phase and which is a filter comprising active charcoal, where the filter cigarette produced with this filter

a) comprises a tobacco strand surrounded by a cigarette paper having a permeability to

air of 20 to 100 CU, or a tobacco strand nonwoven-wrapped by a cigarette paper having a permeability to air of 20 to 100 CU, and

- b) comprises a double filter having a degree of filter ventilation of 5 to 95%, of which the part on the strand side comprises a very voluminous tissue paper comprising 5 to 65 wt.%, preferably 20 to 50 wt.% microfinely ground active charcoal, the part on the mouth side being provided with a filter ventilation zone running in the circumferential direction.

Preferably, the abovementioned substances are added according to the invention to the tobacco strand either individually or in combination with one another. However, these substances can likewise also additionally be added to other components of the tobacco products according to the invention which are accessible to the main smoke stream, and of these preferably the filter part on the mouth side.

According to one embodiment, the tissue paper employed in the filter element on the strand side has a weight per unit area of approx. 40 to 60 g/m², an active charcoal content of 5 to 65% and a thickness of 150 to 200 µm. A preferred variant has a weight per unit area of 50 g/m² and an active charcoal content of 30 wt.% at a thickness of 180 µm.

In a particular embodiment, the filter part of the double filter on the strand side is a core filter according to DE 42 05 658 C2, in which the core is formed from charcoal-containing tissue paper, as in the embodiment mentioned first, which is surrounded by a jacket of material which is virtually impermeable to the main smoke stream. This material which is virtually impermeable to smoke comprises, for example, highly compacted cellulose acetate fibres.

Compared with conventional filter cigarettes of comparable strength, the filter cigarette according to the invention has the advantage that the microcirculation, in particular of the mucous membrane of the mouth, is impaired significantly less and under-supply of tissue is thus prevented if a filter which is active in the gas phase is used and substances which have an antioxidative action are additionally applied to the tobacco strand. This positive effect is significantly intensified in particular if α-tocopherol or tocopherol acetate is added.

In the context of the present invention, it has been found, surprisingly, that - also if a filter which e.g. comprises active charcoal, is active in the gas phase and at the same time retains the particle phase is used - considerable amounts of the substances added which have an antioxidative action pass into the particle phase and the amount thereof is not or only insignificantly reduced by the filter which is active in the gas phase and in the particle phase, the filter or the pores of the filter material which is active in the gas phase not being "blocked", i.e. not blocking up, by these tobacco additives. Surprisingly, an additive or super-additive effect of the individual effects of the combination according to the invention of filter which is active in the gas phase and charging with substances having an antioxidative action occurs here, i.e. an at least additive reduction in the impairment of the microcirculation occurs. On the other hand, it has been found that the content of harmful substances in the gas phase can be reduced by using a filter which is active in the gas phase, without an impairment of taste, i.e. adverse changes in the taste of the main smoke stream, occurring in the case according to the invention. The secondary smoke stream also shows no adverse changes in smell, i.e. those perceived as unpleasant.

Surprisingly, it has furthermore been found that charging of tobacco mixtures which are customary per se with the abovementioned substances having an antioxidative action - even in relatively high contents - contributes towards a sensorial improvement of the particular mixture and of the smokable products according to the invention.

According to a particular embodiment of the invention, the smokable product is a filter cigarette which comprises a tobacco strand nonwoven-wrapped by a cigarette paper having a permeability to air of 40 to 60 CU, the nonwoven paper being a highly porous nonwoven paper having a permeability to air of 32,000 CU, and the filter of which is a double filter, of which the part on the strand side comprises a very voluminous tissue paper comprising 30 wt.% microfinely ground active charcoal and which is provided with a filter ventilation zone running in the circumferential direction which comprises, in the part on the mouth side, cellulose acetate, the tobacco strand being provided with an addition of about 2% tocopherol acetate. The double filter has a degree of filter ventilation of about 20 to about 25%, about 50% or about 60 to 75%, depending on whether it is a full flavour, a light or an ultra-light cigarette. The product properties of these preferred cigarettes are shown below in Tab. 2.

Tab. 2

Product segment	Mixture	Filter	Strand casings	Filter ventilation
Full Flavour	AB (comprises expanded tobacco)	Double filter. on the strand side tissue paper comprising active charcoal with about 20-30 mg microfinely ground active charcoal (corresp. to 30% charcoal).	2-layered: inside: non-woven paper with 32.000 CU outside: conventional cigarette paper with 40-60 CU (in each case for all three product segments mentioned)	at 12 mg condensate about 20-25% admixed air
Light	AB (comprises expanded tobacco)			at 6 mg condensate about 50% admixed air
Ultra-Light	AB (comprises expanded tobacco)	mouth side cellulose acetate (CA) filter (in each case for all three product segments mentioned)		at 2 mg condensate about 60% admixed air at 1 mg condensate about 70-75% admixed air

It goes without saying for the expert that the principle according to the invention - depletion in the gas phase, e.g. by using a filter which is active in the gas phase and/or by using cigarette paper which is active in the gas phase, with simultaneous concentration in the particle phase by charging with substances having an antioxidative action - can also be realized by using tobacco cartridges (so-called push-in cigarettes), i.e. by providing a nonwoven-wrapped tobacco strand and a sheath with a filter which is active in the gas phase, which the consumer pushes together himself to give the finished smoking product (e.g. cigarette). The substances having an antioxidative action can accordingly be added to the tobacco itself and/or, for example, to the cigarette paper of the sheath. The present invention therefore also relates to the use of a nonwoven-wrapped strand of tobacco and/or another smokable material and a filter sheath which comprises a filter which is active in the gas phase to produce a smokable product according to the invention, the strand of tobacco and/or another smokable material and/or other components accessible to the main smoke stream being provided with an addition of substances having an antioxidative action. The present invention likewise also relates to the

analogous use of so-called (non-filtered) "push-in cigarillos" in combination with a filter sheath which comprises a filter which is active in the gas phase, to produce a smokable product according to the invention. The present invention therefore also relates to the use of a strand of tobacco and/or another smokable material which is wrapped with naturally occurring and/or reconstituted tobacco, and a filter sheath which comprises a filter which is active in the gas phase, to produce a smokable product, the strand of tobacco and/or another smokable material and/or the wrapping of tobacco and/or other components accessible to the main smoke stream being provided with an addition of substances having an antioxidative action. According to this embodiment, the strand of tobacco and/or another smokable material alternatively can be wrapped with at least two layers of reconstituted tobacco or foil tobacco. In these cases, the wrapping can be both impermeable to air (≤ 1 CU) and permeable to air (having a permeability to air of 5 to 100 CU, preferably 40 to 80 CU), or can comprise a combination of wrapping tobaccos which are impermeable to air and wrapping tobaccos which are permeable to air.

The invention is explained in more detail below with the aid of examples.

Example 1

Production of test cigarettes

For the investigations described in the following examples 2 and 3, machine-made test cigarettes were produced at the full flavour level on the basis of the cigarette format required for this. 4 different cigarette variants were produced in total (tab. 3).

The charging with tocopherol acetate (ToAc) took place in the form of a 20% ethanolic solution on the cut tobacco. A procedure was followed here in which in each 10 case kg of the tobacco were sprayed with the ToAc solution in a rotating treatment drum in the manner known to the expert. A content of 1.5% ToAc in the tobacco was aimed for during the metering. Thereafter, the solvent was evaporated off at 22°C and 63% rel. atmospheric humidity, conditioning for the cigarette production taking place at the same time (cigarette versions 1 C and 1 D). The untreated tobacco mixture (cigarette versions 1 A and 1 B) served as a comparison in each case.

The cigarettes were produced with two different filters. The filters which were active in the gas phase were double filters, of which the part on the strand side comprises a charcoal-containing tissue paper (with 30 wt.% microfinely ground active charcoal) and the part on the mouth side comprises cellulose acetate fibres. These filters have been called active charcoal filters (AF) in the description and are in cigarette versions 1 B and 1 C. Conventional cigarette filters produced from cellulose acetate fibres (CA) (cigarette versions 1 A and 1 D) were compared with these.

Tab. 3

Overview of the test variants products

Abbreviation used	Content of ToAc (% in the tobacco)	Description of the filters used			
		Type	Filter length		Degree of ventilation (%)
			Total (mm)	Charcoal paper (mm)	
1 A	---	CA	21	---	20
1 B	---	AF	21	13	17
1 C	1.6	AF	21	13	17
1 D	1.6	CA	21	---	20

Example 2

Behaviour of tocopherol acetate during smoking of cigarettes

The behaviour of tocopherol acetate (ToAc) during smoking of full flavour cigarettes in the test variants with cellulose acetate filters and with active charcoal filters was investigated.

The cigarettes were smoked down in accordance with DIN 10240, the condensate of the main smoke stream (MSS) being obtained electrostatically. The particle phase of the so-called

secondary stream (SSS) was also isolated. For this, in each case 10 test cigarettes were smoked down in an 18 m³ chamber lined with V2A steel such that only the SSS was able to disperse in the chamber. Thereafter, an aliquot of 180 l of this was passed at a flow rate of 3 l/min through a Teflon filter to separate out the particle phase.

The stumps (unsmoked tobacco residues) and the smoked cigarette filters were also separated from one another and collected after smoking of the cigarettes. Ethanolic solutions or extracts were prepared from the MSS, SSS, stumps and the smoked filters for analysis for ToAc.

The ToAc was quantified by means of HPLC with DAD (high performance liquid chromatography with diode array detector). A column of the Purospher RP 18, 5 µm, No548163 type was employed for this. Methanol was used as the mobile phase at a flow rate of 1.0 ml/min and a temperature of 35°C. The detection was carried out at 285 nm.

Tab. 4

Passage of tocopherol acetate (ToAc) into the main smoke stream (MSS)

Cigarette variant	MSS condensate (mg/cig.)	ToAc in the MSS condensate (mg/cig.)	Content of ToAc in the MSS condensate (%)
I C	11.3	1.42	12.6
I D	13.3	1.47	11.1

The amounts of MSS condensation (mg/cigarette) and the amounts of ToAc detected therein (mg/cigarette) in the MSS condensate are listed in tab. 4 for the cigarette variants comprising ToAc. The rel. content (%) of ToAc in the MSS can also be seen from tab. 4. The results obtained show that the content of ToAc in the MSS condensate (%) is at a comparable level in the cigarettes with cellulose acetate filters and charcoal filters, and in particular is on average about 12%.

Tab. 5

Recovery of tocopherol acetate after smoking down of the test cigarettes

Cigarette variant	Tocopherol acetate (mg/cigarette)						
	before smoking down	after smoking down, recovered in					
		MSS	SSS	filter	stump	Σ	% recovered
1 C	11.15	1.42	3.83	0.66	2.04	7.95	71.3
1 D	11.58	1.47	3.54	0.84	2.11	7.96	68.7

Tab. 5 gives an overview of the distribution of the ToAc during smoking and the balance after the smoking down process has been concluded. The second column of tab. 5 contains the amounts of ToAc (mg/cigarette) which existed at the start of smoking down. These are obtained mathematically from the particular amount of tobacco per cigarette and the amount of ToAc added in each case to the tobacco.

Tab. 5 also shows the amounts of ToAc recovered (mg/cig.) in the MSS, SSS, filter and stump, and the total resulting therefrom and the amount recovered in each case (%), based on the amount present before the smoking down.

Example 3:

A. General study design to demonstrate the influence on the microcirculation

Material and methods

1. Test objects:

The following 4 test objects were investigated by way of example. All the test objects were used in blind form for the study, i.e. neither the subjects nor the study director could ascertain which cigarette was smoked. The cigarettes were those of the full flavour segment with the following designations according to example 1:

1 A, 1 B, 1 C and 1 D

2. Subjects:

Homogeneous random sample, 8 subjects (N = 8); male, Caucasian, moderate smokers; no dental and medical pathological findings (exception mild chronic bronchitis); dentition cleaned; defined in- and exclusion criteria in accordance with Good Clinical Practice (GCP) - Standard (guidelines for proper clinical trials on medicaments).

Age: 38 to 43 years (mean 40.5 years)

Weight: 73 to 78 kg (mean 75.3 kg)

Height: 172 to 176 cm (mean 174.1 cm)

3. Definition of the inclusion criteria for suitability as a subject:

Male Caucasian, 38 to 43 years, ambulant; no medication; balanced social status; harmonious marriage; no clinical pathological findings; free from influenzal infections for 4 weeks; no physical or mental disabilities; completed at least the 10th class at school (professional training concluded). Reliability and discipline (strict adherence to the investigation instructions). Balanced character (no paranoid or accentuated personality structures). Moderate smoker (10 to 15 cigarettes daily; approx. 0.9 mg nicotine and approx. 12 mg condensate per cigarette); no alcohol abuse, no medicament misuse.

4. Definition of the exclusion criteria (unsuitable as a subject):

Non-observance of the inclusion criteria, see above.

5. General exclusion criteria:

Participation in a study (regardless of the type) in the last 90 days; simultaneous participation in another study. Inability or unwillingness to be able to or want to meet the criteria of the trial plan. Alcoholic, medicament- or drug-dependent, neurotic. Persons with psychiatric illnesses. Epilepsy. Risk of suicide. Blood donor or blood loss > 500 ml in the last 6 months. Weight not within +/- 10% corresponding to size, sex and stature - as in the Metropolitan Life Insurance Company Tables 1983 or Broca Index > 150% or overweight (more than 20%)

above normal weight). Consumption of abnormal amounts of coffee, tea or tobacco in the opinion of the trial doctor; following a diet or unbalanced nutrition in the opinion of the trial doctor; irregular (unsociable) lifestyle; poss. contraindication for the planned investigations (from the medical point of view). No declaration of willingness for the investigations.

6. Case history exclusion criteria:

Allergic diathesis; intolerances or hypersensitivities regardless of the nature; diabetes mellitus; hyperuricaemia; hyperthyroidism or other endocrine diseases; chronic or terminal diseases (carcinoma, tuberculosis); hypertension; cardiac insufficiency, coronary insufficiency; coronary heart disease; heart valve defect; myocardial infarction; cerebral infarction; disturbances in cerebral circulation TIA (transitory ischaemic attacks; stage IIa of disturbance in cerebral circulation); chronic obstructive lung disease GOLD; surgical intervention on the intestine; any other chronic disease, haemodialysis; only one fully functional kidney; prostate hyperplasia; blood coagulation disturbances. Expressed view of wanting to give up smoking.

7. Exclusion criteria to be detected on inclusion:

Chronic liver complaints (increase in transaminases to twice the normal values); kidney diseases or kidney dysfunctions (increase in serum creatinine $> 1.2 \text{ mg\%}$ ($1.5 \text{ mg\%}$) or creatinine clearance $50 - 80 \text{ ml/min}$ ($< 50 \text{ ml/min}$); leukocyte count below $3,500/\mu\text{l}$; platelet count below $100,000/\mu\text{l}$. Suspected intestinal dysfunctions; suspected pulmonary or bronchial diseases (exception mild chron. bronchitis). Stomatologically in need of hygiene; absence of more than 2 teeth; periodontopathies, gingivitis.

8. Inadmissible concomitant treatment:

Taking of medicaments or substances within 90 days before the start of the study; non-medicamentous therapy; physiotherapy.

9. Secondary exclusion criteria:

Inclusion criteria not met after the preliminary examination, exclusion criteria only detected after inclusion in the study (excluded in the context of this study).

10. Framework conditions for the investigations:

- a) Subjects: No alcohol, no coffee, tea or Coca-Cola® 12 h before the investigation times. At least 6 hours sleep a day; before the measurements, sufficient acclimatization and rest (blood pressure RR (measured with a Riva-Rocci apparatus) normal, heart rate normal, respiratory rate normal).
- b) Measurements: Room temperature approx. 22°C, relative atmospheric humidity approx. 75%. Measurements seated (head is placed in an ophthalmological mount during the investigation - at the express wish of the subjects). Same time of day (hour); same weather situation.

Study character

Double-blind study (progress of the investigations determined by a randomization generator).

Observation interval, measurement interval

Starting values,

0th minute start of exposure;

during and after the exposure

2nd minute;

4th minute;

6th minute;

8th minute;

10th minute;

12th minute.

Framework conditions of the investigations constant (temperature regulation,

macrocirculation, acclimatization time approx. 2 h).

Exposure conditions

Orientating framework conditions in respect of respiratory rate and breath volume; the subjects maintain their usual smoking behaviour during smoking. Each subject is exposed to all the test objects of an investigation series (time interval between exposures > 24 h). The sequence of the subjects in the study and the sequence of the exposures to the various test objects for each subject is determined by a randomization generator.

B. Intravital microscopy method **(Method description, features)**

Continuous, complete microvessel networks are recorded in a target tissue volume of 1 mm³ with 60 Kirchhoff nodal points (sites of microvessel branchings) and average vessel diameters of < 40 µm.

Before recording of each intravital microscopy measurement value, an orientating overview of the complete network in the tissue target volume is obtained - including its further in- and outflows, branching geometry and branching hierarchy. Vessel identification, if necessary, takes place functionally in the context of this study.

To show complete microvascular networks in the target region, an intravital microscopy examination unit using the combined incident light-transmitted light method with selective light generators and selective filtering is employed. Handling and processing of the primary images obtained is computer-assisted (secondary image handling and processing with the KONTRON computer system).

The vital microscopy findings are recorded under defined illumination and filter conditions; these relate to: spectral distribution of the incident light and transmitted light components, beam characteristics, angle of incidence of the incident light component, specific filtering of the reflected component and the components penetrating through the tissue, emission and

absorption spectra of the various structures in the target tissue.

Documentation of the primary images:

Instantaneous microphotographs in small image, film reel or plate format (NIKON, LINHOF with ARRI adaptor; to 1/8,000 sec); film material to ISO 3200/36°.

35 mm cinefilm (colour or black-and-white), complete camera and control system ARRI (up to 120 images/sec), Agfa special film; automatic Agfa film development system.

Video records (U-matic, Super-VHS; JVC, PANASONIC, BLAUPUNKT, SIEMENS).

The various geometric and dynamic features of the microcirculation are measured with computer assistance by means of image-to-image analysis; in some cases in pseudo-colour transformation and computer identification of the primary images (computer-assisted histological findings). For the intravital microscopy measurements, the macrocirculatory framework conditions are to be kept strictly constant and are to be monitored simultaneously.

Fig. 1 shows, with the aid of a block circuit diagram, the construction of the intravital microscopy examination unit.

Adaptation of the vital microscopy examination unit with a BAXTER angioscope glass fibre cable:

The distal part of a BAXTER angioscope (spec. coronaroscope) is placed in a commercially available sterile O.P. swab such that fixing of the optical apparatus on the buccal side is ensured and at the same time the subject is stressed in an acceptable manner. This procedure is simulated with the subject before the start of the investigation and is accepted by all the test persons. Fig. 2 shows a diagram of the placing of the distal optical apparatus in the cavum oris of the subjects.

At the request of the subjects, the head is fixed in an unconstrained manner by an ophthalmological mount (jaw support, forehead support) - adapted individually in the seated

position - during the exposure to the test objects. No defined exposure conditions are specified to the subjects during application of the test objects; they may proceed in the manner of their habits (draw volume, draw frequency, number of draws per test object, time).

The following features of the microcirculation are measured:

* Number of nodal points nNP currently perfused with blood cells in a defined network unit (stated as absolute values or as percentage changes compared with the starting values),

This feature describes the assignment of the perfusion states as "perfused with blood cells" or "not perfused with blood cells" according to the following criteria: duration of the state longer than 20 sec; limit cases are evaluated with + 0.5 or - 0.5; limit flow rate of the red blood cells $v \sim 80 \mu\text{m/s}$.

* Number of adhering white blood cells on a defined venole inner wall nWBC/A (stated as absolute values or as percentage changes compared with the starting values).

This features designates the number of adhering white blood cells n which adhere to a defined venole inner wall surface A for longer than 5 sec. The reference area is an area of the venole inner wall $A = 18,000 \mu\text{m}^2$; average diameter of the venules $d = 40 \mu\text{m}$, axial venole length $l = 140 \mu\text{m}$.

* Arteriolar and venular flow Q_{art} and Q_{ven} (stated as absolute values or as percentage changes compared with the starting values).

This feature describes the flow (flow intensity) of the red blood cells, that is to say the particle flow.

Recording of the measurement values is computer-assisted in secondary image processing (KONTRON system). Geometric dimensions within a microvessel (diameter d, radius r) are measured perpendicular to the longitudinal axis of the vessel from the inner surface of the endothelium to the opposite inner surface of the endothelium (tangents). This is shown in

diagram form in fig. 3.

C. Statistical analysis of the measurement values

For obvious reasons, a parameter-free test method is used. Under the prerequisite of constant variables in small but biometrically sufficiently large random samples, the WILCOXON rank sum test is used, since with an efficiency of approx. 95% it is one of the most precise parameter-free methods. The tests are performed at the significance level $\alpha = 5\%$. The critical values of T for the WILCOXON test are taken from: G.A. Ferguson, Statistical Analysis in Psychology and Education. McGraw-Hill, N.Y. 1959, 318.

The starting values are compared with the measurement values at the measurement times of the 2nd minute to 12th minute for each test object. It is furthermore tested whether significantly different feature changes occur after exposure to various test objects (comparison of the measurement values after exposure to various test objects at the same measurement times).

D. Study procedure

Before the start of the investigation, the subjects are acclimatized and their circulation calmed in the seated position (thermogrammometric monitoring of the body shell temperature, measurement of the systemic systolic and diastolic blood pressure, preliminary general medical examination); a preliminary detailed medical discussion on the current condition of the subject then takes place (approx. 20 min). The preliminary medical discussion pursues the aim of prolonging the acclimatization period, calming the subject further and building up and consolidating a firm study doctor-subject confidence relationship (adherence to the framework conditions and instructions for the subject before the start of the investigation).

Exposure to the particular test object and the recording of findings are then carried out in the laboratory in a seated position in the context of a double-blind study.

After the findings have been recorded, the subject is invited to a follow-up medical discussion. The follow-up discussion serves to further consolidate the confidence relationship and to prepare the subject for the next investigation time.

During the follow-up discussion, the subject is also asked about the test object of the exposure which has taken place, to ascertain whether e.g. due to individual aversion to a particular test object, redundant mental or vegetative-somatic factors could have falsified the measurement result. No indications of such falsifications were obtained in the context of the present study.

E. Results

The means of the measurements with 8 subjects are shown in graph form in fig. 4 and 5.

Fig. 4 shows, by way of example, the number of nodal points (nNP) perfused with blood cells as a function of time for cigarette versions 1 A to 1 D according to example 1.

Fig. 5 shows the number of adhering white blood cells nWBC/A as a function of time for cigarette versions 1 A to 1 D according to example 1.

It can be seen from fig. 4 that the microperfusion (microcirculation) determined with the aid of the number of nodal points perfused with blood cells is impaired to a very much greater degree with conventional filter cigarettes (1 A) than in the case of filters which are active in the gas phase (1 B). As fig. 4 furthermore shows, charging with tocopherol acetate (1 D) also reduces the impairment of the microcirculation compared with conventional filter cigarettes to a comparable extent. With filter cigarettes according to the invention, which are distinguished by the combination of a filter which is active in the gas phase with a tobacco strand charged with substances having an antioxidative action (here tocopherol acetate 1 C), there is a further significant lessening of the effects on the microcirculation observed during smoking. A few minutes after the end of the exposure, the number of nodal points perfused with blood cells increases again to the starting value before the exposure.

It can be seen on fig. 5 that the number of adhering white blood cells (nWBC/A), as a measure of the immune response, is significantly higher during exposure to smoke of conventional filter cigarettes (1 A) than in cases where conventional filter cigarettes are charged with tocopherol acetate (1 D). In the case of filter cigarettes according to the invention which comprise filters which are active in the gas phase and an addition of substances having an antioxidative action

(here tocopherol, 1 C), on the other hand, the lowest immune response - expressed as the number of adhering white blood cells - is observed.

This series of tests shows that filter cigarettes according to the invention impair the microcirculation significantly less compared with conventional filter cigarettes, and thus represent a significant improvement from the biological-medical aspect in respect of acute effects on the microcirculation.

Example 4

Tobacco treatment with curcumin or ferulic acid ethyl ester

Cigarettes of the full flavour level, described in example 1 as version 1 A, were used as a comparison in order to evaluate the active substances curcumin and ferulic acid ethyl ester in respect of their passage into the MSS and their physiological action, described in example 5.

A procedure was followed here in which in each case 100 g cut tobacco, as contained in cigarettes 1 A, were charged with ethanolic solutions of curcumin or ferulic acid ethyl ester. After the alcohol had evaporated off, hand-made cigarettes which corresponded to those of comparison 1 A in respect of their format were produced with the tobacco. The three cigarette versions were smoked down as described in example 2.

Thereafter, analyses for curcumin or ferulic acid ethyl ester were carried out on the treated tobaccos and the condensates of the MSS. The analyses were carried out by means of HPLC, as described in example 2. However, a mixture of water, tetrahydrofuran, acetonitrile and acetic acid was used as the mobile phase, and in particular in a ratio of 55/25/20/1 for curcumin and a ratio of 77/13/9/1 for ferulic acid ethyl ester. A Purospher C18 column was used, and the detector was set at 420 nm for curcumin and 325 nm for ferulic acid ethyl ester. The following tab. 6 shows the concentration of active compound (%) which the treated tobacco had, and the % content recovered in the MSS condensate.

Tab. 6Test objects for example 5

Test no.	Active substance	Active compound in the tobacco (% dry matter)	Passage into the main smoke stream (%)
B 142	ferulic acid ethyl ester	0.44	34.81
B 143	curcumin	0.87	0.63
1 A	---	---	---

Example 5

The action of the filter cigarettes produced according to example 4 on the microcirculation of the mucous membrane of the mouth of 8 subjects was investigated in a double-blind study with the intravital microscopy test methods described in more detail in example 3 (sections A.2 to D. [method part]).

Test objects:

1 A, B 142 and B 143

Results:

Fig. 6 shows, by way of example, the number of adhering white blood cells nWBC/A as a function of time for the full flavour cigarettes (according to example 4) with and without the additives curcumin and ferulic acid ethyl ester (versions 1 A, B 143 and B 142).

It can be seen from fig. 6 that the immune response - measured as the number of adhering white blood cells (nWBC/A) - is significantly higher during exposure to smoke of conventional filter cigarettes (1 A) than in cases where conventional filter cigarettes are charged with substances having an antioxidative action, such as curcumin (B 143) or ferulic acid ethyl ester

(B 142).

Example 6

An American Blend mixture was charged with 2 wt.% tocopherol acetate (based on the amount of tobacco) and the corresponding test and comparison cigarettes were produced analogously to example 1.

The sensorial result in the panel of experts showed a significant reduction in the so-called interference factors such as reactivity, roughness and pungency in the test cigarettes comprising 2 wt.% ToAc compared with the comparison cigarettes.

Other mixture systems (i.e. use of other tobacco mixtures charged with 2 wt.% ToAc) were likewise also investigated. A significant reduction in pungency was also determined in a straight Virginia mixture (cigarette), and a considerable reduction in roughness and reactivity was determined with a pure air cured mixture (cigarillo), the typical "cigarry" smell of the secondary smoke stream of the cigarillos filtered and charged according to the invention being evaluated as less pronounced and less unpleasant than the SSR smell of the comparison cigarillos.

Legend of the Figures:

Fig. 1: Block diagram of the intravital microscopy examination unit

Fig. 2: Diagram of placing of the distal optical apparatus in the cavum oris of the subjects.

The glass fibre cable is embedded in a sterile O.P. swab so that acceptable fixing between the dental lamina of the right lower jaw and the inside of the cheek is ensured.

Fig. 3: Diagram of the inside of a microvessel to illustrate the determination of geometric dimensions

Fig. 4 Measurement of the number of nodal points perfused with blood cells as a function of time after the start of exposure in investigations of conventional filter cigarettes and filter cigarettes according to the invention.

Fig. 5: Measurement of the number of adhering white blood cells as a function of time after the start of exposure in investigations of conventional filter cigarettes and filter cigarettes according to the invention.

Fig. 6: Measurement of the number of adhering white blood cells as a function of time after the start of exposure for full flavour cigarettes with and without additives.

Patent Claims Annexed to the IPEA Report

Patent claims:

1. Smokable product, **characterized in that** it
 - a) comprises a filter which is active in the gas phase and/or cigarette paper which is active in the gas phase and/or one or more other components accessible to the main smoke stream comprise an addition of substances which are active in the gas phase and
 - b) the strand of tobacco and/or another smokable material and/or other components accessible to the main smoke stream is/are provided with an addition of substances having an antioxidative action,wherein an at least additive reduction in the impairment of the microcirculation occurs due to the combination of a) and b).
2. Smokable product according to claim 1, **characterized in that** it is a filter cigarette, a filter cigarillo or a filtered cigar.
3. Smokable product according to claim 1 or 2, **characterized in that** the filter comprises 5 to 65 wt.% of a material of large surface area.
4. Smokable product according to claim 3, **characterized in that** the filter comprises 20 to 50 wt.% of a material of large surface area.
5. Smokable product according to claim 4, **characterized in that** the filter comprises 30 wt.% of a material of large surface area.
6. Smokable product according to claims 1 to 5, **characterized in that** the filter comprises a means for introducing ventilation air.
7. Smokable product according to claims 1 to 6, **characterized in that** the filter has at

least one filter ventilation zone running in the circumferential direction in the part on the mouth side

8. Smokable product according to claims 1 to 7, **characterized in that** the degree of filter ventilation is 5 to 95%.
9. Smokable product according to claim 8, **characterized in that** the degree of filter ventilation is 25 to 75%.
10. Smokable product according to claims 1 to 9, **characterized in that** the product comprises a tobacco strand wrapped with cigarette paper or a tobacco strand wrapped with nonwoven paper and cigarette paper casing, in which the permeability to air of the cigarette paper is 10 to 100 CU and in which the permeability to air of the nonwoven paper is 4,000 to 60,000 CU.
11. Smokable product according to claim 10, **characterized in that** the permeability to air of the cigarette paper is 20 to 60 CU.
12. Smokable product according to claims 1 to 11, **characterized in that** the filter is a compartment filter, an interspersed filter, a monoblock filter, a double filter, a core filter or a multifilter, the multifilter being any desired combination of filters from the group consisting of compartment filters, interspersed filters, monoblock filters and/or core filters.
13. Smokable product according to claim 12, **characterized in that** the filter is ventilated with channels and/or has a recess filter section on the mouth side and/or a core filter on the mouth side.
14. Smokable product according to claim 2, **characterized in that** it is a filter cigarette with a tobacco strand surrounded by a cigarette paper, in which the filter is a double filter or a multifilter, of which the part on the strand side comprises a tissue paper which comprises 5 to 65 wt.% of a material of large surface area.

15. Smokable product according to claim 2, **characterized in that** it is a filter cigarette with a tobacco strand surrounded by a cigarette paper, in which the filter is a monofilter which comprises a tissue paper which comprises 5 to 65 wt.% of a material of large surface area.
16. Smokable product according to claims 13 to 15, **characterized in that** the tissue paper comprises 20 to 50 wt.% of a material of large surface area.
17. Smokable product according to claim 16, **characterized in that** the tissue paper comprises 30 wt.% of a material of large surface area.
18. Smokable product according to claims 13 to 17, **characterized in that** the filter has a filter ventilation zone running in the circumferential direction in the part on the mouth side, the tissue paper of the filter part on the strand side is a very voluminous paper, the permeability to air of the cigarette paper is 10 to 100 CU and the degree of filter ventilation is 5 to 95%.
19. Smokable product according to claim 18, **characterized in that** the permeability to air of the cigarette paper is 20 to 60 CU.
20. Smokable product according to claim 18 or 19, **characterized in that** the degree of filter ventilation is 25 to 75%.
21. Smokable product according to claims 13 to 20, **characterized in that** the part of the filter on the strand side is a core filter with a core of tissue paper according to one of the preceding claims, which is surrounded by a jacket of material which is virtually impermeable to the main smoke stream.
22. Smokable product according to claims 1 to 21, **characterized in that** the filter which is active in the gas phase and/or the cigarette paper which is active in the gas phase and/or the components accessible to the main smoke stream in each case comprise

material of large surface area from the group consisting of active charcoal, aluminium oxide, aluminium hydroxide, bentonite, cellulose, kieselguhr, ion exchangers, light metal salts, sepiolite, molecular sieves, silica gels, aluminas, zeolites or combinations thereof.

23. Smokable product according to claim 22, **characterized in that** the material of large surface area is active charcoal, sepiolite or silica gel.
24. Smokable product according to claim 22 or 23, **characterized in that** the material of large surface area has a particle size of 2 mm or less and has an internal specific surface area in the range from 50 m²/g to 2,000 m²/g.
25. Smokable product according to claim 24, **characterized in that** the particle size is 15 µm to 2 mm or less than 15 µm.
26. Smokable product according to claims 1 or 2, **characterized in that** it is a filter cigarette which
 - a) comprises a tobacco strand surrounded by a cigarette paper having a permeability to air of 20 to 100 CU or a tobacco strand nonwoven-wrapped by a cigarette paper having a permeability to air of 20 to 100 CU and
 - b) comprises a double filter having a degree of filter ventilation of 5 to 95%, of which the part on the strand side comprises a very voluminous tissue paper comprising 5 to 65 wt.% microfinely ground active charcoal, and which is provided in the part on the mouth side with a filter ventilation zone running in the circumferential direction.
27. Smokable product according to claim 26, **characterized in that** the tissue paper comprises 20 to 50 wt.% of a material of large surface area.
28. Smokable product according to claims 1 to 27, **characterized in that** the tobacco

strand is provided with an addition of more than 0.1 wt.% of substances having an antioxidative action.

29. Smokable product according to claim 28, **characterized in that** the tobacco strand is provided with an addition of more than 0.1 wt.% to 5 wt.% of substances having an antioxidative action.
30. Smokable product according to claim 29, **characterized in that** the tobacco strand is provided with an addition of more than 0.5 wt.% to 4 wt.% of substances having an antioxidative action.
31. Smokable product according to claim 30, **characterized in that** the tobacco strand is provided with an addition of 1 to 2.5 wt.% of substances having an antioxidative action.
32. Smokable product according to claims 1 to 31, **characterized in that** the substances having an antioxidative action are chosen from the group consisting of ascorbic acid, β -carotene, retinol, tocopherol, its derivatives and precursors, eugenol, jasminaldehyde, cinnamon, cinnamon extract, (crude) coffee, (crude) coffee extract, coffeic acid methyl ester, coffeic acid ethyl ester, ferulic acid methyl ester, ferulic acid ethyl ester, umbelliferone, scopoletin and curcumin, it being possible for the substances to be added to the tobacco either individually or in combination with one another.
33. Smokable product according to claim 32, **characterized in that** the substance having an antioxidative action is α -tocopherol, tocopherol acetate and/or tocopherol succinate.
34. Smokable product according to claims 1 to 33, **characterized in that** the tobacco strand is provided with further additions of auxiliaries, fillers and aroma substances.
35. Smokable product according to claim 1 or 2, **characterized in that** it is a filter cigarette which comprises a tobacco strand nonwoven-wrapped by a cigarette paper

having a permeability to air of 40 to 60 CU, the nonwoven paper being a highly porous nonwoven paper having a permeability to air of 32,000 CU, and the filter of which is a double filter having a degree of filter ventilation of about 20 to about 25%, of which the part on the strand side comprises a very voluminous tissue paper comprising 30 wt.% microfinely ground active charcoal, which is provided with a filter ventilation zone running in the circumferential direction which comprises cellulose acetate in the part on the mouth side, the tobacco strand being provided with an addition of about 2% tocopherol acetate.

36. Smokable product according to claim 1 or 2, **characterized in that** it is a filter cigarette which comprises a tobacco strand nonwoven-wrapped by a cigarette paper having a permeability to air of 40 to 60 CU, the nonwoven paper being a highly porous nonwoven paper having a permeability to air of 32,000 CU, and the filter of which is a double filter having a degree of filter ventilation of about 50%, of which the part on the strand side comprises a very voluminous tissue paper comprising 30 wt.% microfinely ground active charcoal, which is provided with a filter ventilation zone running in the circumferential direction which comprises cellulose acetate in the part on the mouth side, the tobacco strand being provided with an addition of about 2% tocopherol acetate.
37. Smokable product according to claim 1 or 2, **characterized in that** it is a filter cigarette which comprises a tobacco strand nonwoven-wrapped by a cigarette paper having a permeability to air of 40 to 60 CU, the nonwoven paper being a highly porous nonwoven paper having a permeability to air of 32,000 CU, and the filter of which is a double filter having a degree of filter ventilation of about 60 to about 75%, of which the part on the strand side comprises a very voluminous tissue paper comprising 30 wt.% microfinely ground active charcoal, which is provided with a filter ventilation zone running in the circumferential direction which comprises cellulose acetate in the part on the mouth side, the tobacco strand being provided with an addition of about 2% tocopherol acetate.
38. Smokable product according to claims 1 to 34, **characterized in that** it is a filter

cigarette, the tobacco strand of which is wrapped with two layers of cigarette paper, the inner layer comprising a cigarette paper of low permeability to air which reduces the secondary smoke stream and the outer layer comprising an aromatized cigarette paper having a permeability to air of 20 to 100 CU.

39. Smokable product according to claim 38, **characterized in that** the aromatized cigarette paper has a permeability to air of 40 to 80 CU.
40. Smokable product according to claims 1 to 34, **characterized in that** it is a filter cigarillo with an enveloping leaf of foil tobacco which is permeable to air or impermeable to air and a covering leaf of naturally occurring tobacco and a compartment filter, the central compartment of which is filled with active charcoal.
41. Use of a nonwoven-wrapped strand of tobacco and/or another smokable material and a filter sheath which comprises a filter which is active in the gas phase for the production of a smokable product according to claims 1 to 39, **characterized in that** the strand of tobacco and/or another smokable material and/or other components accessible to the main smoke stream is/are provided with an addition of substances having an antioxidative action.
42. Use of a strand of tobacco and/or another smokable material wrapped with naturally occurring and/or reconstituted tobacco and a filter sheath which comprises a filter which is active in the gas phase for production of a smokable product according to claims 1 to 34 and 40, **characterized in that** the strand of tobacco and/or another smokable material and/or the wrapping of tobacco and/or other components accessible to the main smoke stream is/are provided with an addition of substances having an antioxidative action.
43. Use of a strand of tobacco and/or another smokable material wrapped with at least two layers of reconstituted tobacco or foil tobacco and a filter sheath which comprises a filter which is active in the gas phase for the production of a smokable product according to claims 1 to 34 and 40, **characterized in that** the strand of tobacco and/or

another smokable material and/or at least one wrapping of tobacco and/or other components accessible to the main smoke stream is/are provided with an addition of substances having an antioxidative action.

44. Use according to claim 42 or 43, **characterized in that** the wrapping is impermeable to air or permeable to air or comprises a combination of wrapping tobaccos which are impermeable to air and wrapping tobaccos which are permeable to air.

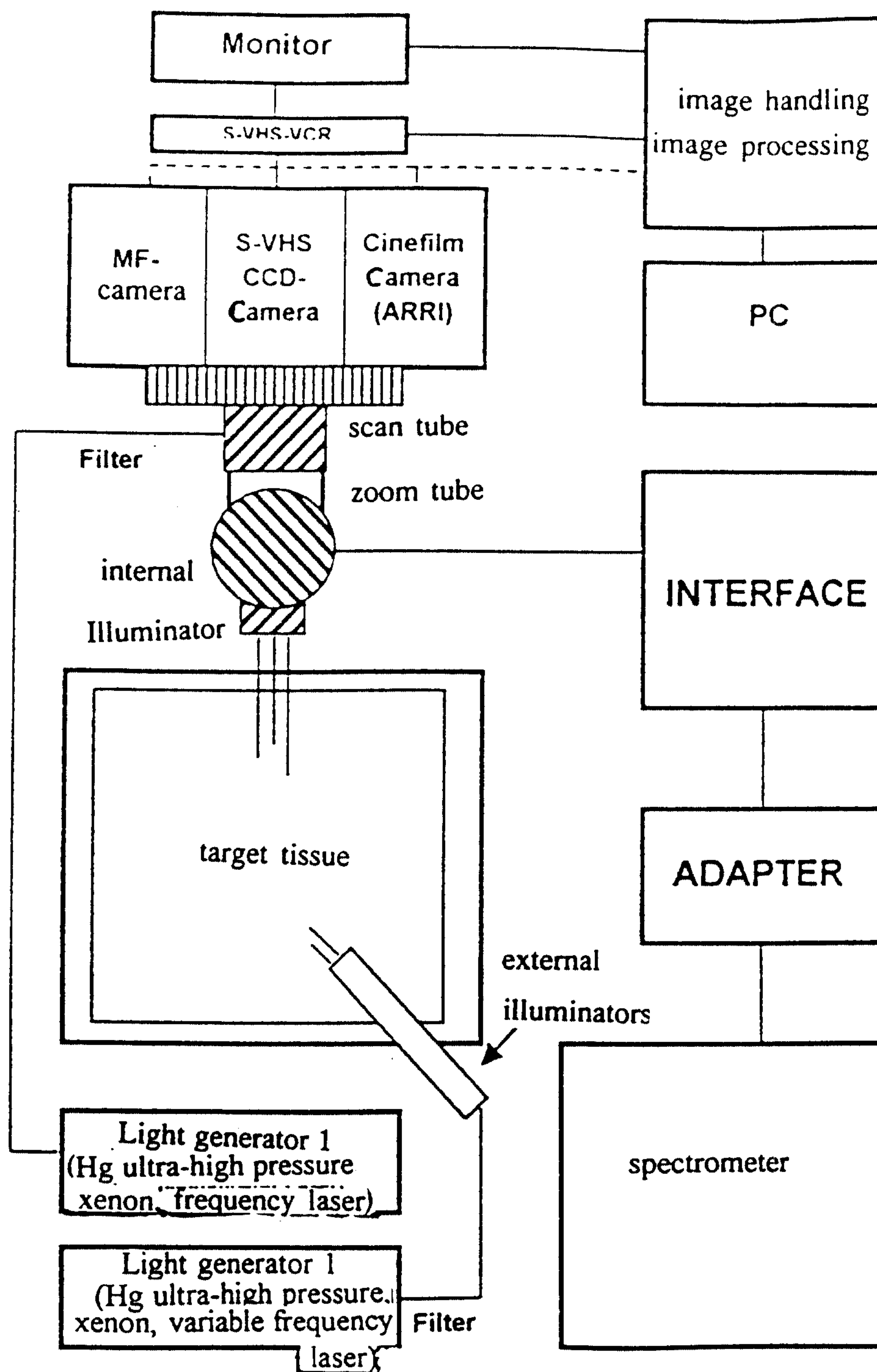


Fig. 1:

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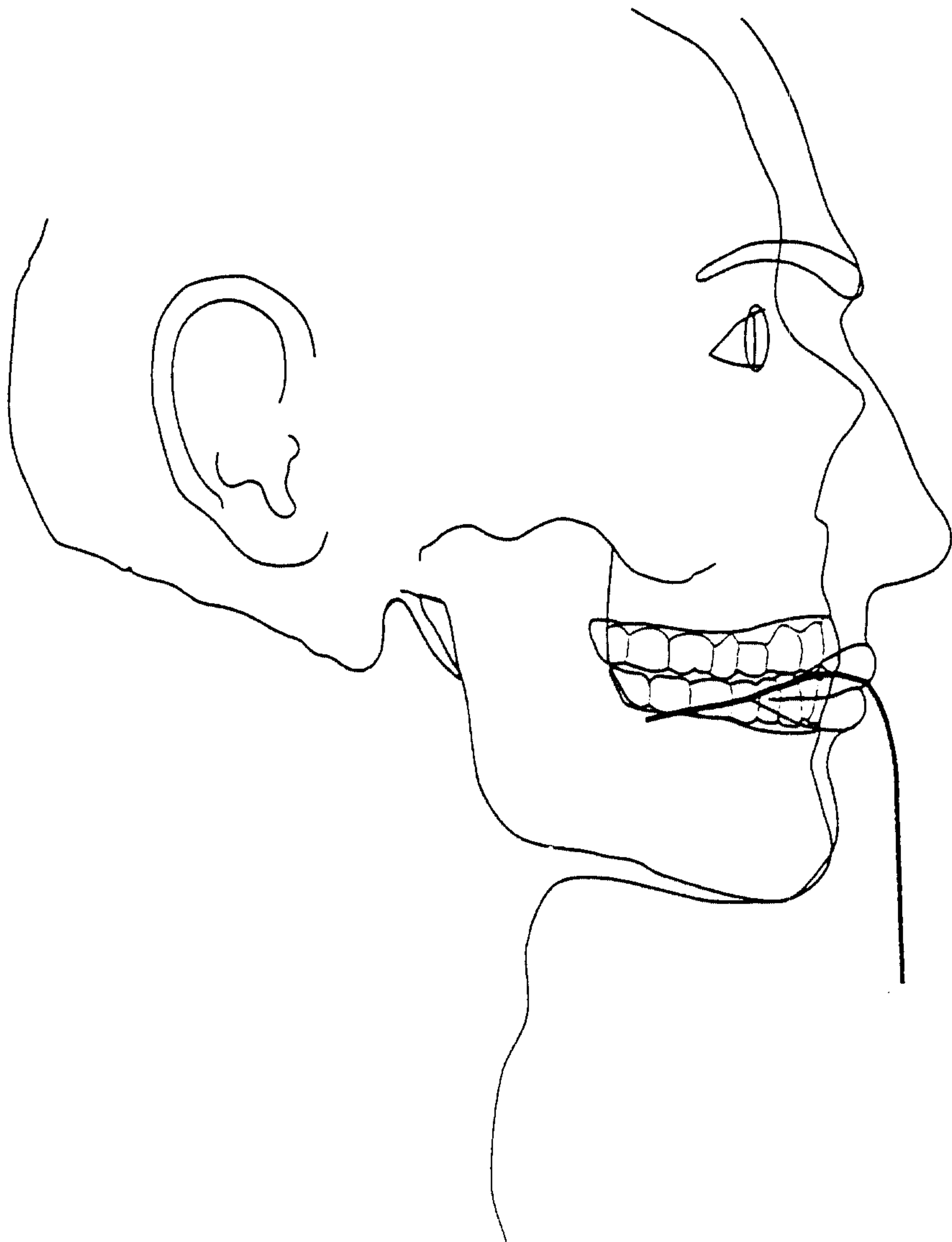


Fig. 2:

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capillary with erythrocyte

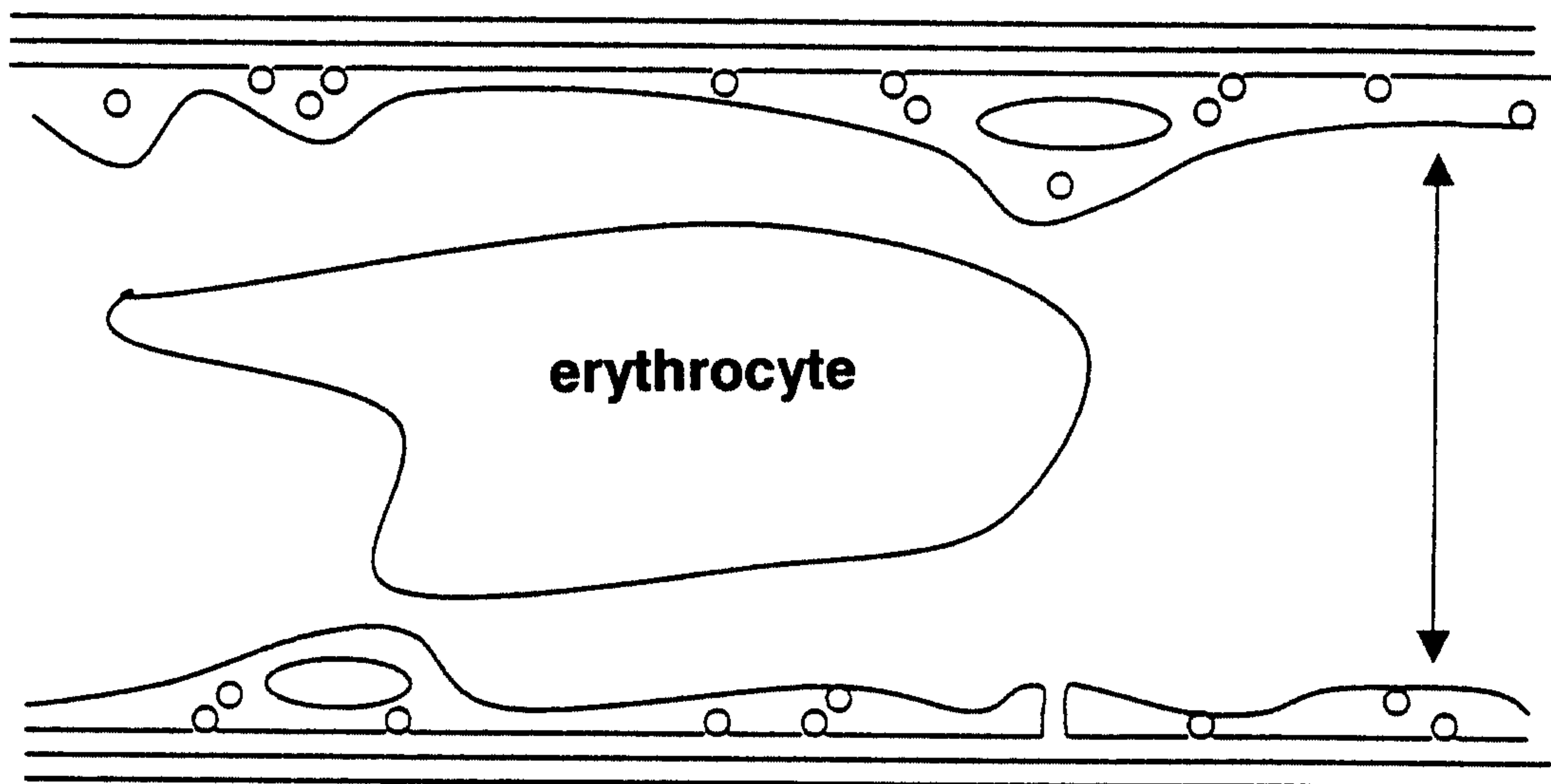
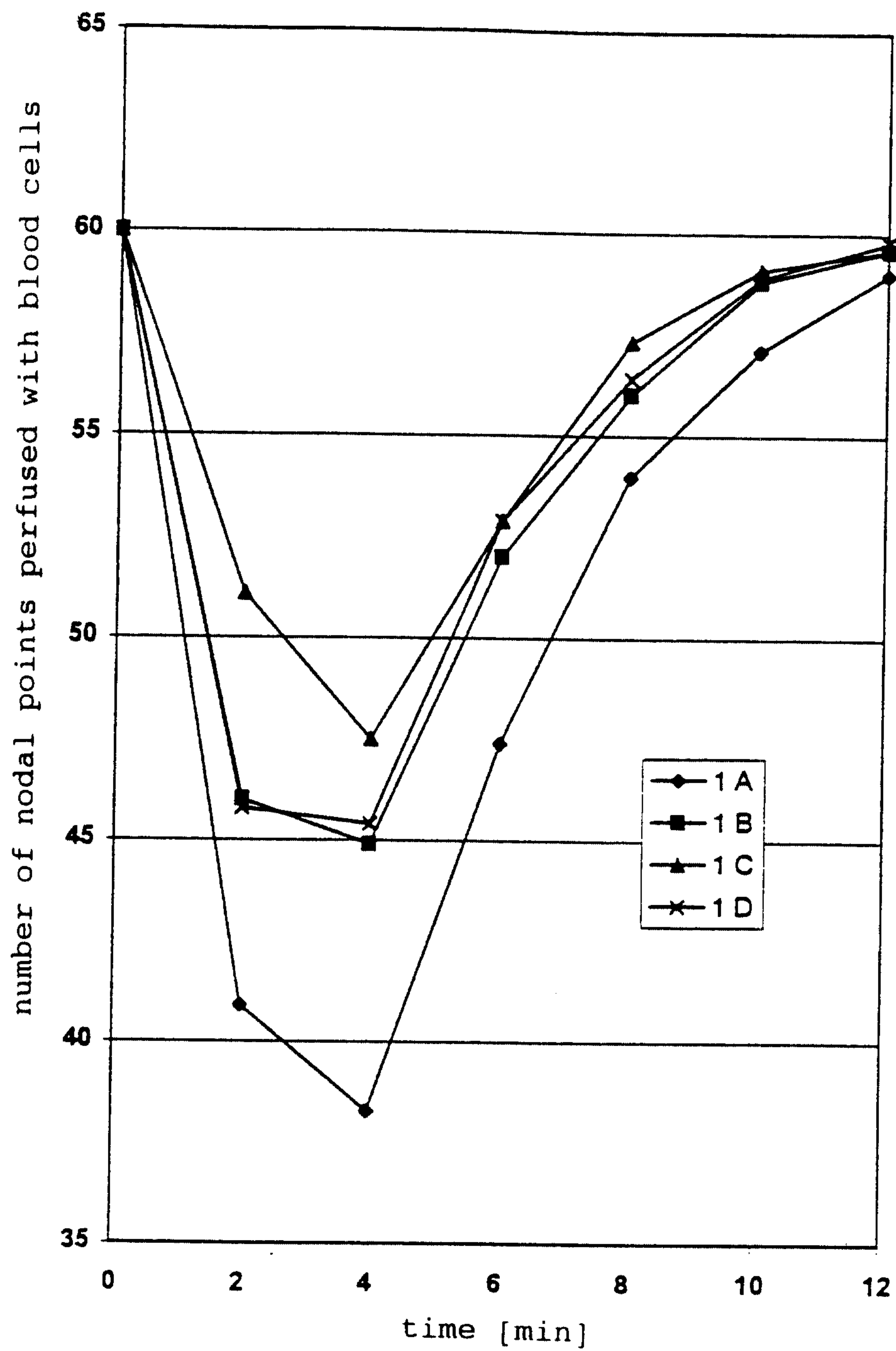
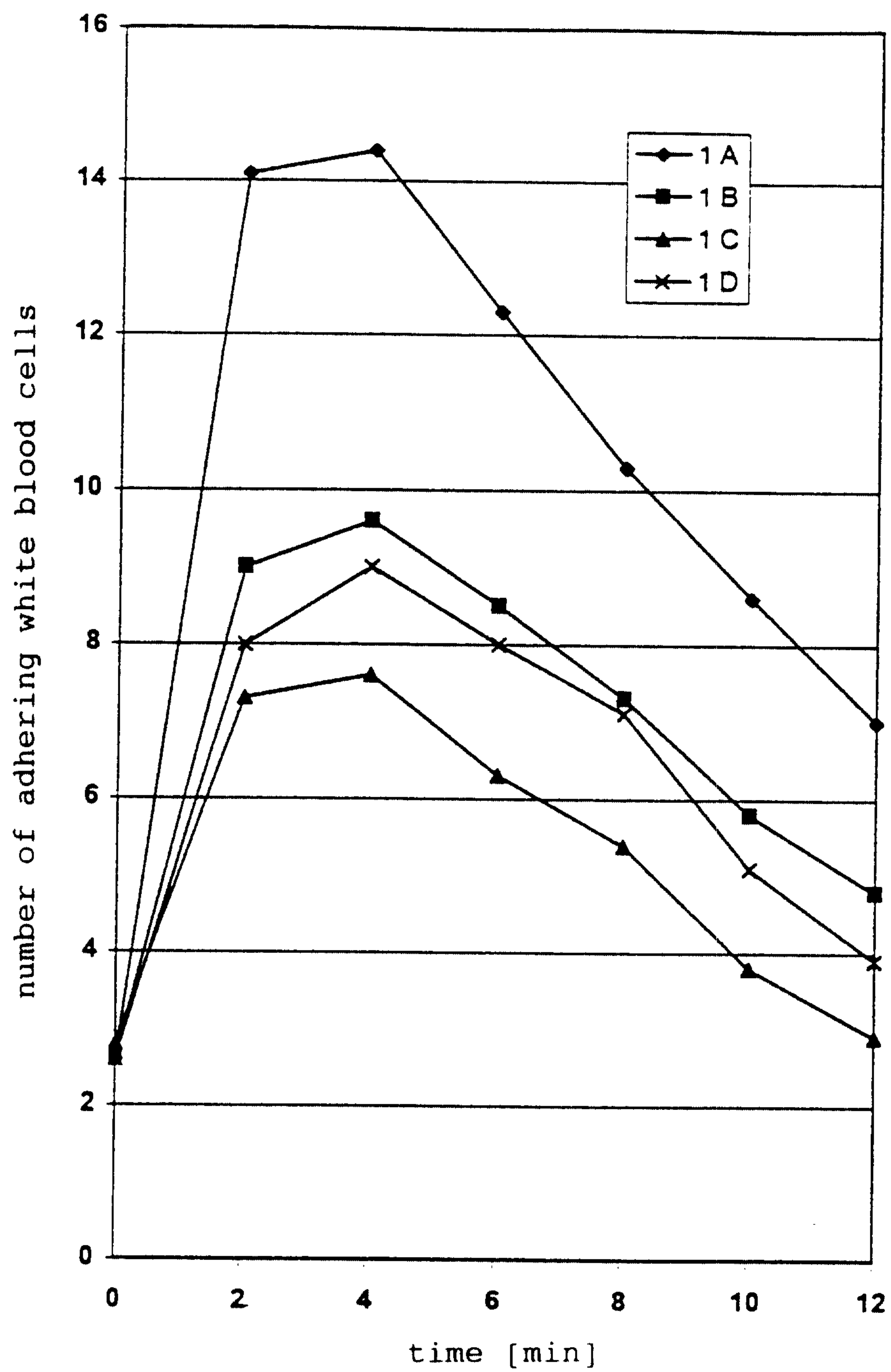


Fig.3:

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Fig. 4:

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Fig. 5:

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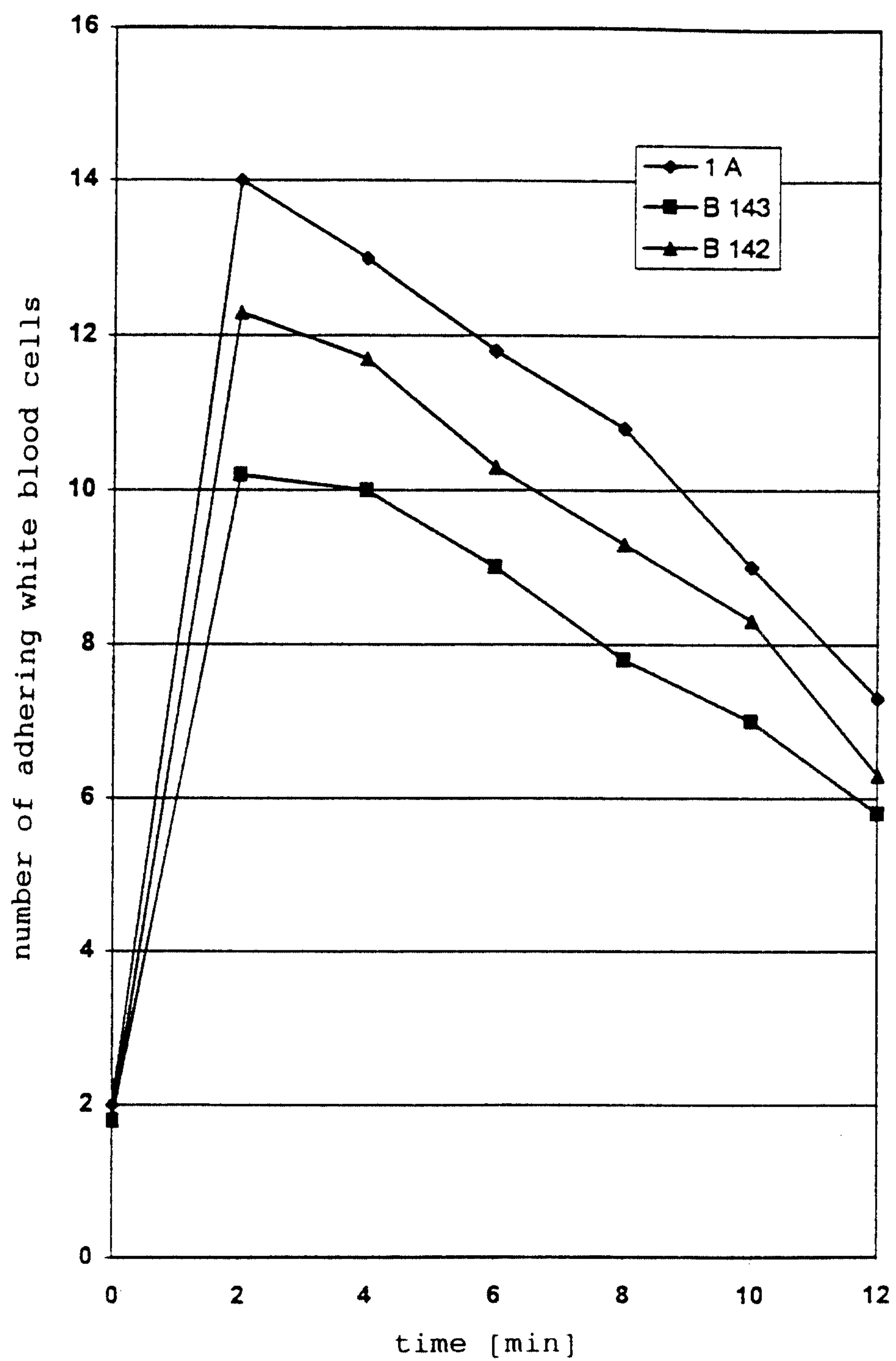


Fig. 6:

number of adhering white blood cells

